APRIL 1906 10 CENTS

TECHNICAL WORLD MAGAZINE

Physical &
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BY

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BY

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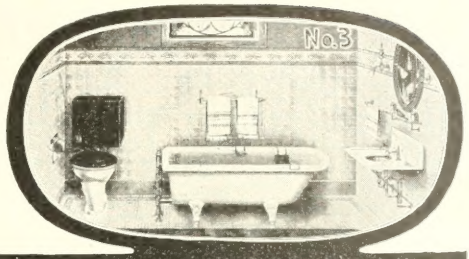

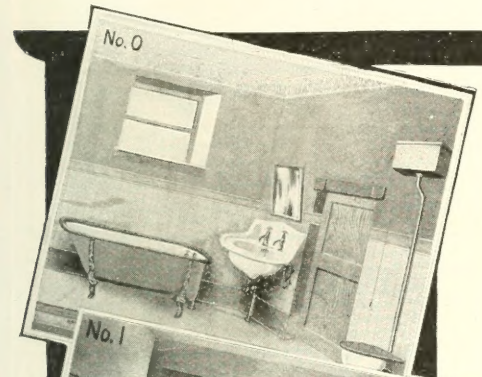

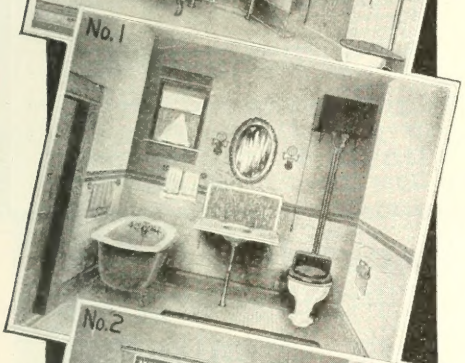

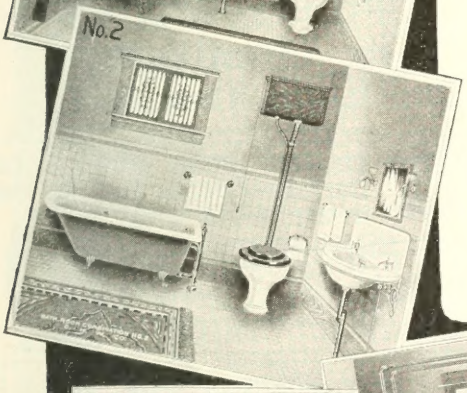

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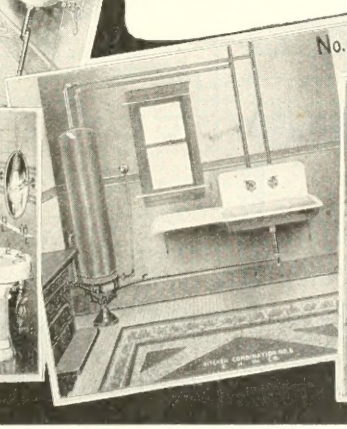

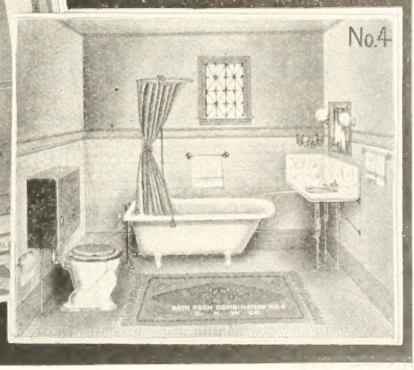

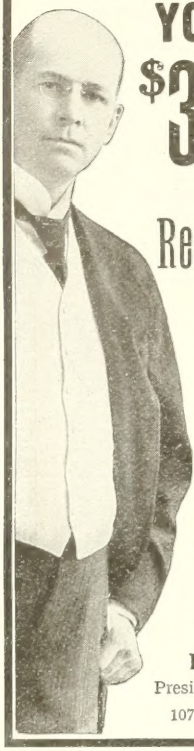

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The TECHNICAL WORLD MAGAZINE

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THE TECHNICAL WORLD MAGAZINE is a monthly magazine, published the fifteenth of each month, preceding date, devoted to the problems of the technical and industrial world, and a treatment of all matters of interest in Applied Science.

PRICE: The subscription price is $1.00 per year, payable in advance; single copies, 10 cents.

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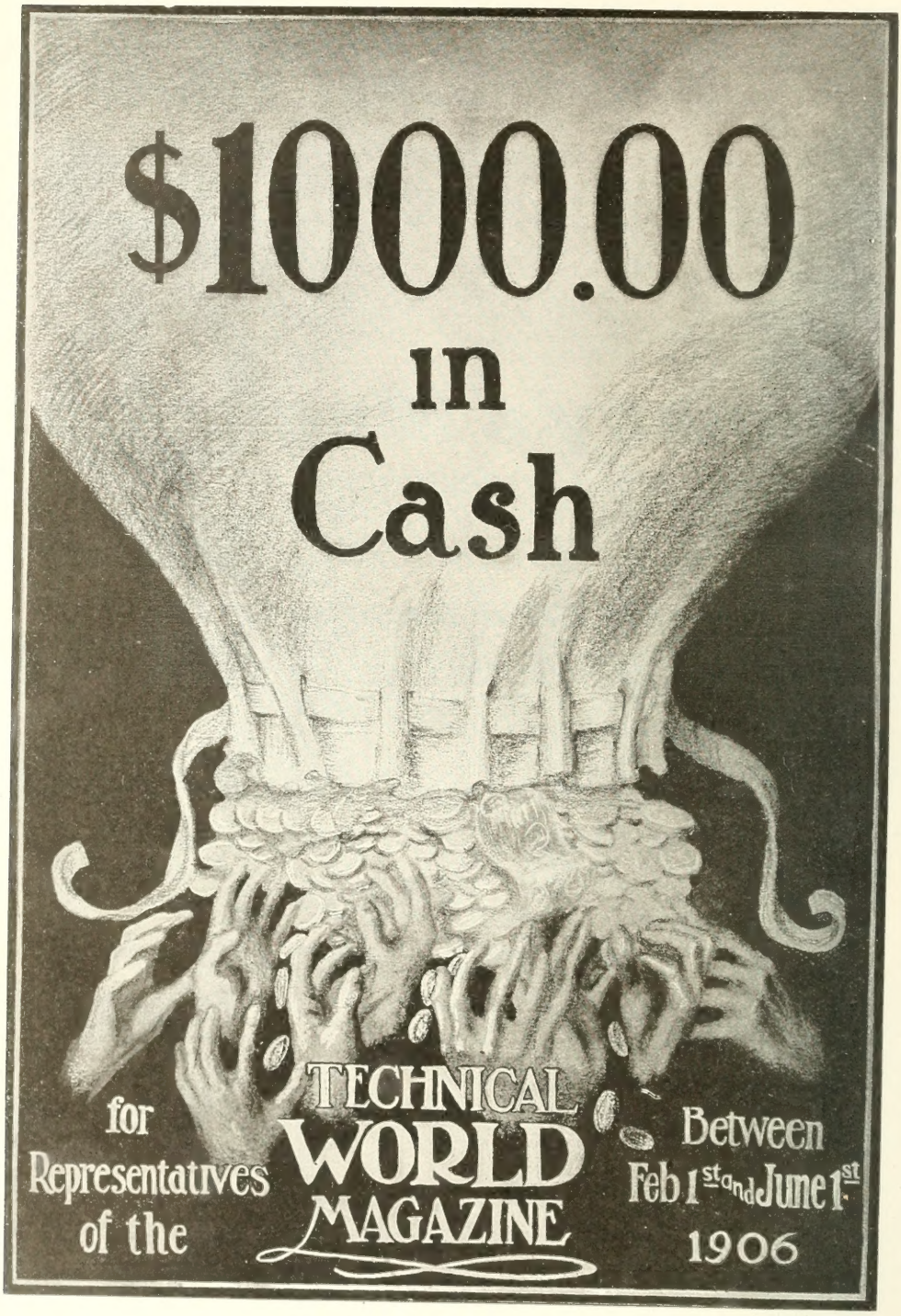
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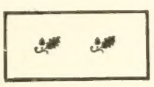

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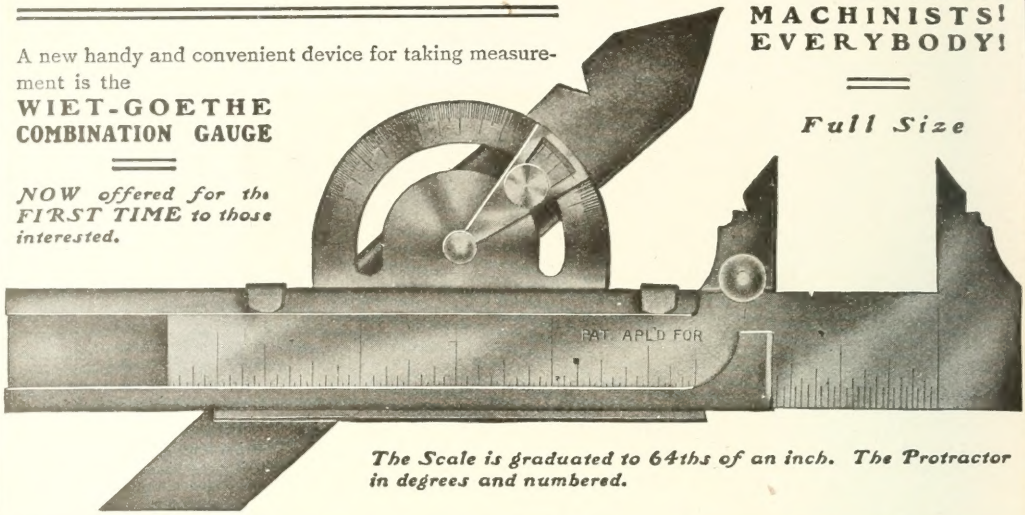

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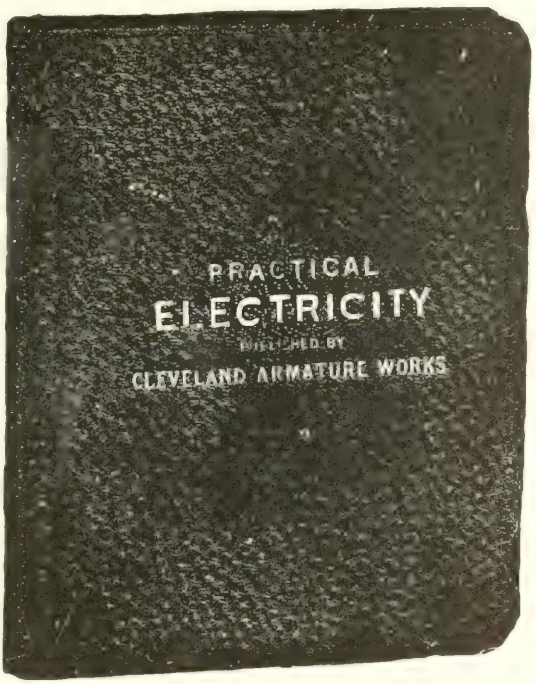

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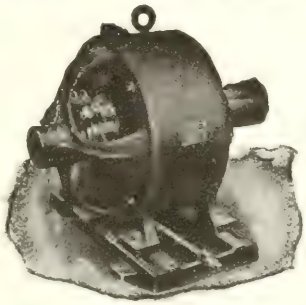

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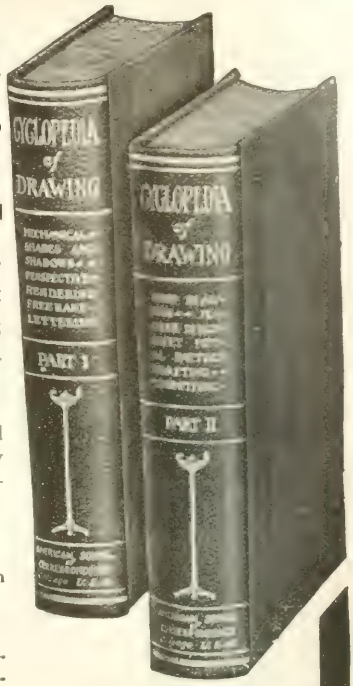

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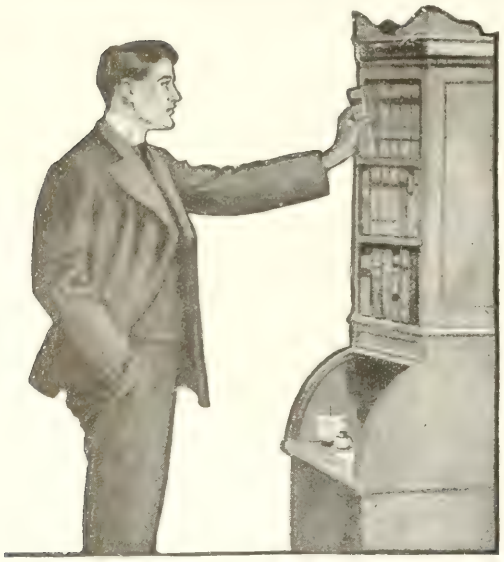

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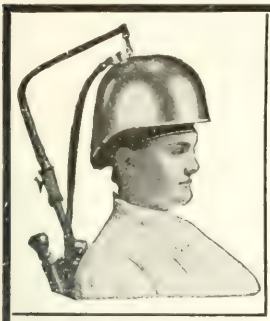

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FOR APRIL

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The April number will be a typical number, an embodiment of entertainment and literary taste to which these readers bear witness.

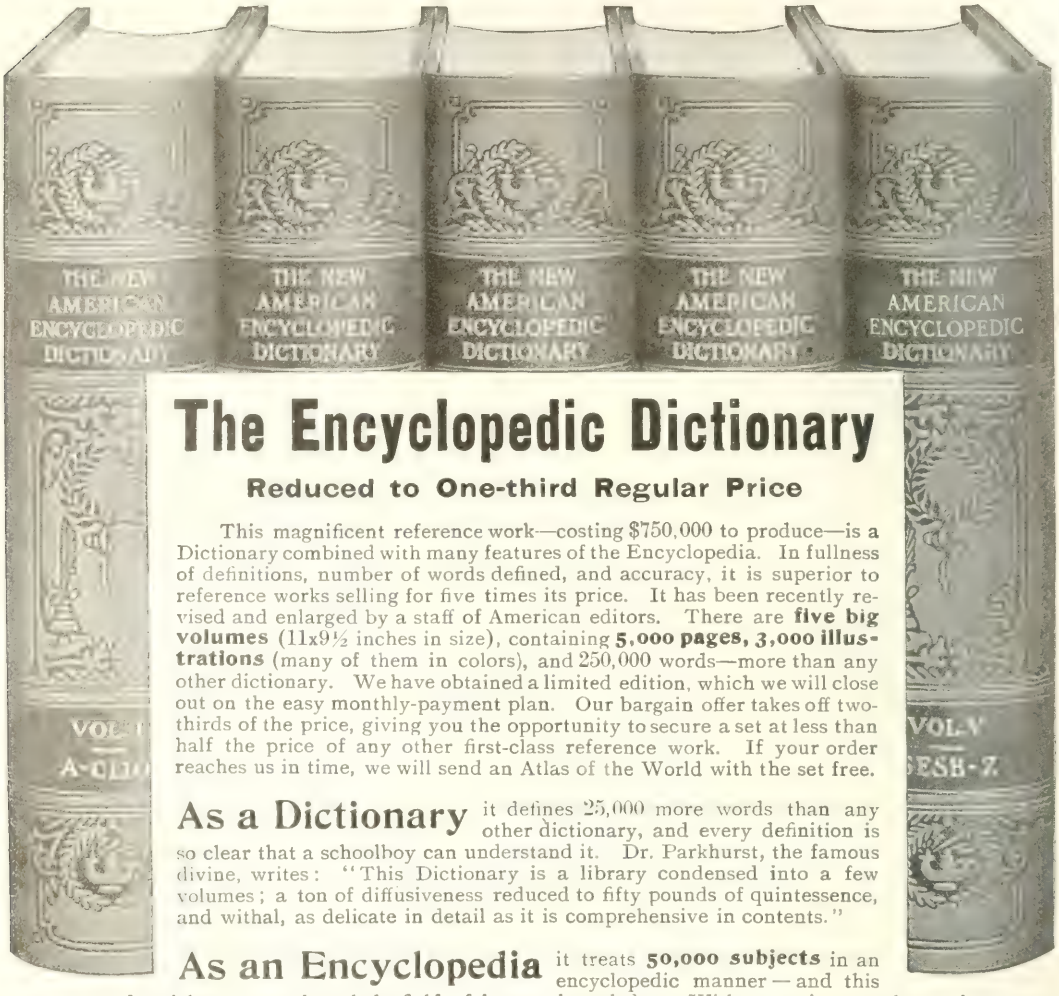
The novelette is **"Capricious Caroline,"** by *E. Maria Albanesi*, author of "Susannah and One Other." It is a story with an ingenious plot and great dramatic interest.

The short stories include a Philippine tale, **"Grim-Visaged War,"** by *Anna A. Rogers*, author of "Peace and the Vices"; an exciting and amusing automobile story, **"In the Limousine,"** by *Churchill Williams;* a skilfully written and entertaining dialogue, entitled **"The Truth,"** by *May Harris*, giving the masculine and feminine points of view of a delicate question of ethics; one of *Joseph C. Lincoln's* best tales, called **"The Reincarnation of Captain Strabo";** a racing story, **"The Lady and the Handicapper,"** by *P. S. Carlson;* and stories—the best work of their authors—by *Lucia Chamberlain*, *Cyrus Townsend Brady*, *Grace MacGowan Cooke* and *Jane Maurice*.

Mary Manners will contribute **"The Easily Divorced,"** another of her essays in the series entitled "Society as a Merry-go-Round," which have proved an immense success. *Anne Rittenhouse* will have one on a topic of great contemporary interest and importance, **"The Growth of the Household."**

Channing Pollock will continue his keen observations on theatrical matters.

AINSLEE MAGAZINE COMPANY, NEW YORK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THE AMERICAN FALL AT NIAGARA.

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The Technical
World Magazine

Volume V APRIL, 1906 No. 2

BILLION DOLLAR STEEL TRUST MAKES MICROBES PAY DIVIDENDS

By HENRY M. HYDE

Author of "The Buccaneers"

THIS is the tragedy of the billion-dollar steel trust—biggest thing of its kind in the world—and the typhoid fever germ—so small that a few thousand of them can promenade on the point of a pin. A round million dollars a year is involved in the plot. And, incidentally, there are probably several thousand able-bodied voters, walking about and declaiming against greedy monopolies, who, but for the intelligent greed of this particular octopus, would now have moss growing over their epitaphs.

A By-Product Formerly Wasted

In all the tremendous mills now owned by the American Steel & Wire Company—one of the big brothers in the United States Steel Corporation family—millions of tons of steel plates and rods are daily given a bath in sulphuric acid. This acid bath cleans the steel of grease and other impurities before the rods are drawn out into wire and the plates are covered with a deposit of tin. At the same time, it removes the iron oxide or rust from the surface of the metal.

So long as the mills remained under individual ownership and management—and for some time after they were taken into the trust—the acid bath was used day after day, until finally the acid lost its strength. Then the tanks were emptied and their contents run off into the sewers, to be replaced by a new supply of H_2SO_4. Occasionally, indeed, a curious chemist took some of the useless contents of the tanks, before they were emptied, and, by evaporation, secured some greenish crystals of sulphate of iron, popularly known as copperas or green vitriol. This was formed, of course, by the reaction between the sulphuric acid and the iron rust. There was even some small market for this salt. It was used in the grinding of plate glass, as a mordant for fixing and setting dyes and colors, and in paper mills. But the demand was small, and, so long as the mills remained in the hands of individual owners, no one of them produced enough sulphate of iron to make the preservation of the by-product commercially profitable.

When all the great steel and wire

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WATERWORKS PUMPING STATION, ST. LOUIS, MO.

plants came under one management, a Department of Chemicals was organized, with Mr. A. T. Weaver at its head. One of the objects of this department was to save and make money out of the sale of various chemical by-products of the mills.

New Method of Purifying Water

One day, about three years ago, within a week after Mr. Weaver had taken charge of the department, a casual order came into his office for a few hundred pounds of sulphate of iron. The writer, who was at the head of the city waterworks at Quincy, Ill., had heard that the Steel & Wire Company occasionally saved some of the salt. Could they supply him?

Now, Mr. Weaver had already figured out that there was going to waste in the plants of the company a total of 150,000 tons of sulphate of iron, annually. He was eagerly looking for a market which could absorb such an enormous quantity. Here was an order from the superintendent of a waterworks. What on earth could he want with 600 pounds of copperas? Mr. Weaver wrote to ask what it was to be used for. In the meantime, the man who gave the order happened to be in Chicago, and visited the office of the Steel & Wire Company to inquire how soon the goods would be shipped.

Before he got away, he had furnished information which will eventually mean a clean saving to the American Wire & Steel Company of a round million dollars a year. It means, besides, on the authority of many expert sanitary engineers, that there is now at hand a new, comparatively inexpensive, and entirely successful method of quickly purifying water in large quantities, absolutely destroying all disease germs and removing foreign substances. In other words, there is no longer any legitimate reason why any city, town, or village should not furnish its citizens with a copious supply of perfectly pure water for all domestic purposes.

"Why," said the man from Quincy, "we're using the sulphate of iron, in connection with lime, to purify our water."

That was a new idea. Sulphate of iron and limewater had been used for the chemical precipitation of sewage; but never before it was suggested by Mr. W. B. Bull of the Quincy Waterworks, had

the two been used together for the mechanical purification of drinking water.

"Will you let us send down a chemical engineer and a bacteriologist to make a thorough investigation of your method?" asked Mr. Weaver.

"Send them along," said the Quincy scientist. "They'll find that it does the work."

Mr. Weaver sent for Ernest E. Irons, the bacteriologist, and told him what was wanted.

"Go down and spend as much time as is necessary to get at the facts," he said.

"I'm almost sure there's nothing in it," answered Mr. Irons. "I think you'll be wasting your money to send me down there."

"Then you're the very man we're looking for. If you go prejudiced against the process, and come back converted, we can be sure it's a good thing."

Mr. Irons went to Quincy, and stayed there for six months. He came back and made an enthusiastic report in favor of the process. He found that the use of sulphate of iron and lime, in connection with the large filters, resulted in the production of a perfectly pure and palatable water, clear and brilliant, comparing favorably with the purest spring water. In this opinion he was backed by James E. Campbell, M. S. C. I., chemical engineer, who spent two weeks in studying the Quincy process.

With this report as a foundation, the American Steel & Wire Company started to exploit the use of sulphate of iron and lime for the purification of turbid and infected water.

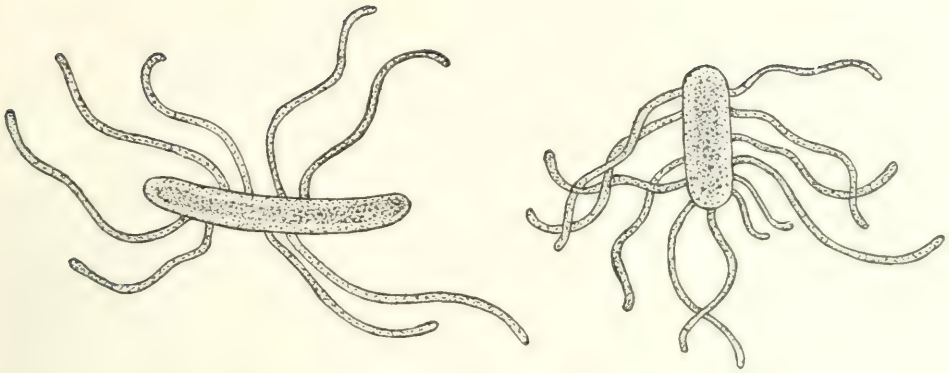
Free Expert Service

One of their first steps was the permanent employment of C. Arthur Brown, a well-known sanitary engineer. The services of Mr. Brown were at once put at the free disposal of any municipality in the country which wished to improve the quality of its water supply. While the object of the company was, of course, to secure a large market for its production of sulphate of iron, Mr. Brown is instructed to do his work in an unbiased and scientific way, recommending the use of sulphate of iron only when it appears to his professional judgment to promise the best and most economical results. Mr. Brown stands ready to visit any city interested in purifying its water supply, to make a thorough investigation—in-

THE ST. LOUIS WATERWORKS.
General view of settling basins.

WATERWORKS AT ANDERSON, INDIANA.

Photograph taken at the time official tests showed the absolute success of the iron and lime process, with sulphate of copper, in destroying all disease germs.



TYPHOID FEVER BACILLI MAGNIFIED MANY THOUSAND TIMES.

cluding analyses of the water, if necessary—and to recommend what appears to him to be the best method of improving conditions.

A Chemical Dragnet

When the sulphate of iron and lime solutions are put into water, they form a thick, white, flocculent precipitate. This precipitate sinks to the bottom of the filter beds and catches in its meshes—roughly speaking, like a net—all the dirt and other impurities suspended in the water, and a very large percentage of all the germs and microbes, both harmful and harmless, so that the water, after leaving the filters, is perfectly clear and clean and contains not more than one per cent of the germs it originally contained.

But even one per cent of germs—provided they be typhoid fever germs, for instance—might kill a number of people, and it was apparent that the iron and lime process—like all the others then commercially practicable—was open to that serious objection.

Death to Typhoid

About this time the government scientists of the Department of Agriculture announced their discovery that a small amount of sulphate of copper would absolutely destroy all the animal and vegetable germs in a very large quantity of water. At once, Mr. Brown, with the coöperation of the government chemists and bacteriologists, instituted a series of careful and thorough tests of the effect of a minute proportion of copper sulphate in connection with the regular sulphate of iron and lime solutions. These tests were made at Anderson, Indiana, in February, 1905, under most trying conditions. The water supply of Anderson is obtained from the White river, into which the city of Muncie empties its entire sewage at a distance of twenty-five miles above the Anderson Waterworks plant. At the time of the experiments, the river was covered with ice so that water at Anderson was taken from

C. Arthur Brown,
Sanitary Engineer, American Steel & Wire Company.

ONE OF THE SETTLING BEDS AT THE ST. LOUIS WATER PLANT.
Showing formation of the flocculent, white iron and lime precipitate.

what was practically a covered sewer—shut off from the purifying effects of air and sunlight—full of diluted sewage.

By adding one per cent of sulphate of copper to the regular sulphate of iron solution—used in connection with lime—it was found not only that all the disease germs were absolutely destroyed, but also that a perfectly pure and brilliant water was delivered from the filters, without

INTERIOR OF WATERWORKS AT ANDERSON, INDIANA.
In right foreground are shown tanks for treating water by the iron and lime process.

ST. LOUIS WATERWORKS.
Showing waterworks trolley line owned by city.

the slightest trace of either iron or copper in it.

In order to get these results, it is necessary to vary the proportion of copper and the other chemicals to suit the varying conditions of the water treated. It is also necessary that the filtering plant be in good working order, and that the whole process be under the charge of a man of proper intelligence and probity.

Up to the present time, forty cities—including St. Louis, Mo.; East St. Louis, Ill.; St. Joseph, Mo.; Marietta, Ohio; Quincy, Ill.; Vicksburg, Miss.; Little Rock, Ark.; Danville, Ill.; Aurora, Ind.; and Pontiac, Ill.—are using the process.

Out of a total possible production of 150,000 tons of sulphate of iron a year, the big company has already disposed of over 25 per cent on yearly contracts to

VIEW OF SETTLING BASINS, ST. LOUIS WATERWORKS.
Gate houses are shown on either side.

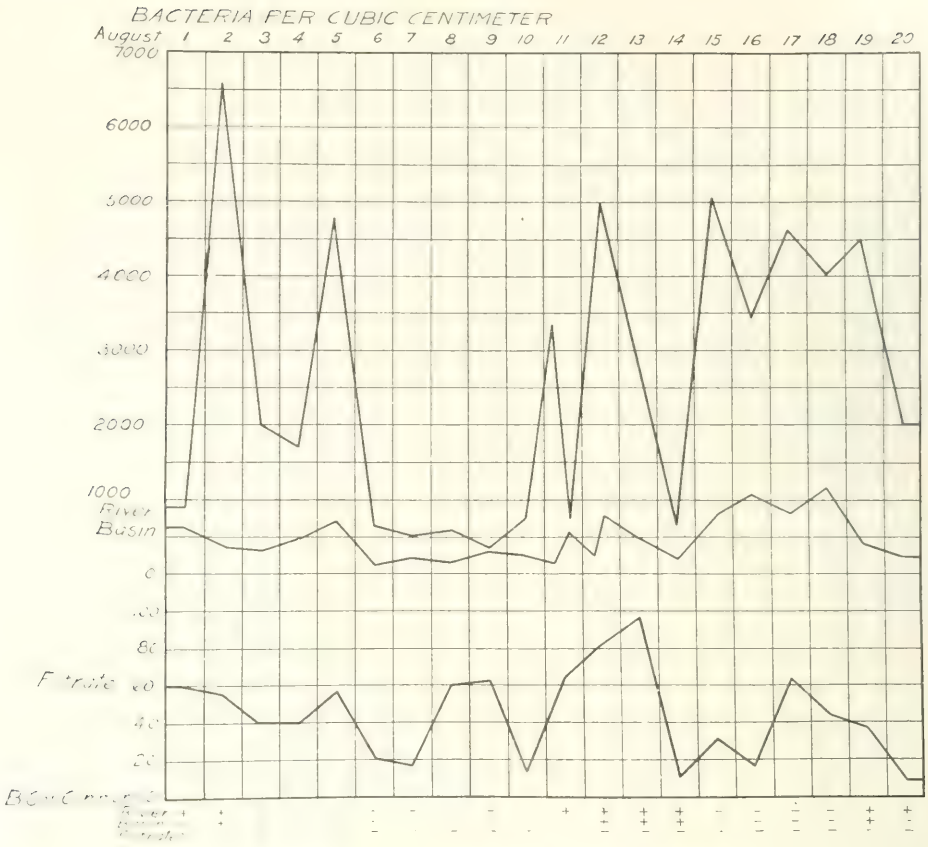


DIAGRAM SHOWING FLUCTUATION IN BACTERIAL INFECTION.

In natural water, settled water, and water treated by the iron and lime process. Tests extending over 20 days. Note entire absence of disease germs in the filtered water.

the cities on its list. As it also produces copper sulphate as a by-product, the addition of that chemical will only add to its profits. The number of cities using the process is rapidly increasing, the amount paid by them for sulphate of iron already amounting to over a quarter of a million dollars a year. When the whole possible product of 150,000 tons is contracted for, the gross annual income of the trust from this source will be about $1,200,000.

The cost of purifying water by the process ranges from $1.50 to $2.50 a million gallons, according to the percentage of impurities it contains.

Niagara Falls Already Ruined

Concessions for Power Plants Already Granted Sufficient to Use All the Water—The Remedy

By ALTON D. ADAMS

Consulting Hydraulic Engineer

NIAGARA FALLS are already ruined! Already enough water rights have been granted by New York State and Canada to divert all the water which now, falling over both the American and the Canadian falls, makes the great cataract one of the natural wonders of the world. If the capitalists and promoters who now hold franchises were all to establish plants, the entire flow of Niagara river would be diverted into underground channels; and the mighty cliff over which the torrent now pours in resistless grandeur would be left rugged and bald and dry.

That is the situation. What, now is the remedy?

In the first place it is to be considered that the American Falls are in much more imminent danger than the Canadian. The pipe line, canal, and tunnels that already pierce the cliffs between the upper river and Niagara Gorge, are large enough in themselves to carry twice the amount of water which runs over the American Falls. And the depth of water above the brink of these falls is only a small fraction of the depth above the Canadian falls. It is therefore possible for the American Falls to run entirely dry, while an imposing depth of water still runs over the Horseshoe on the Canadian side.

One suggestion looking towards the

HEAD OF THE NIAGARA RAPIDS.

American Channel, Goat Island, Bath Island, and the Canadian Channel, as seen from the New York shore.

NIAGARA IN FULL FLOW.
View of the American Falls, taken from Goat Island.

preservation of Niagara, is that a treaty be negotiated between the United States and Great Britain, which shall take the whole matter out of the field of commercial speculation.

Quick Action Needed

Evidently, if anything is to be done by treaty to save the American Falls, it must be done quickly, or it will cost untold millions to buy out vested interests. But the logic of the situation is against any prompt, decisive action in the way of international agreement. Under the Constitution of the United States, New York has no power to enter into any treaty with Canada or Great Britain as to Niagara Falls. A treaty between the United States and Great Britain looking to the preservation of the American Falls can of course be reached only by mutual agreement; and it is at least probable that Canada will oppose such a treaty to the full extent of her great influence with the mother country. This forecast of the probable attitude of Canada is based on two important facts: one of these is the greater width and depth of the Canadian channel, which insures a lusty flow of water over the Horseshoe Falls after the American channel is dry and bare. At the head of Goat Island, the American channel has no more than 15 per cent of the entire width of Niagara river; and it is most probable that no considerable part of that channel reaches a depth of

DRY NIAGARA.

The American Falls at low water caused by ice-jam in channel above. Showing scenic effects of depletion of channel Compare with view on opposite page taken from practically same spot.

10 feet, while much of it is covered with only three or four feet of water. The Canadian channel not only occupies 85 per cent of the entire width of the stream, but also has a depth in parts of at least 26 feet, as was discovered in building the cofferdam for one of the power plants in Queen Victoria Park.

Question of Revenue

The other highly important fact bearing on the probable attitude of Canada toward any treaty that has for its object the preservation of the American Falls, is the great possible revenue that the Government of the Dominion may derive from the rental of water rights. Already Ontario Province receives through the Commissioners of Queen Victoria Niagara Falls Park a minimum annual rental of $60,000 for the water rights granted there; and when the power plants for which these grants were made are operated at their full capacity, the annual revenue to the Government therefrom will rise to more than $300,000.

According to the report made to these Commissioners by an engineer employed for that purpose, power plants which would divert another 30,000 cubic feet of water per second from the upper Niagara river—raising the total volume covered by grants from the Ontario Government to 62,000 cubic feet per second

NIAGARA RIVER ABOVE GOAT ISLAND.
View from New York bank.

—could be conveniently located near Queen Victoria Park. Such a grant, at the water rates previously exacted, would raise the annual revenue of the Ontario Government to more than $600,000 per year from this source; and even then only one-half of the discharge of 165,000 cubic feet per second that comes down Niagara river would be diverted, if the capacity of power plants on the New York side of the Falls was not increased. Long before the rentals due the Ontario Government reached this last-named figure, however, the American Falls would disappear. As Canada would still have the Horseshoe Falls but little impaired by the diversion of some 80,000 cubic feet of water per second, is it probable that the Government there, out of kindness to the United States, would willingly forego the princely revenue named above, in order to save the American Falls?

Deepen American Channel

Fortunately it is not necessary to await the uncertain termination of the negotiation of a foreign treaty, in order to preserve the cataract between Goat Island and the New York bank. New York State has it within its power so to deepen the river channel south of Goat Island, and between that island and the New York bank, that the American Falls will always divide with the Horseshoe whatever water is not diverted from its natural bed.

Under the Treaty of Ghent, the international boundary line in Niagara river passes some 1,200 feet from the head of

HON. THEODORE E. BURTON.

Representative in Congress from Cleveland, O., who has introduced a joint resolution intended to save Niagara Falls.

Lake Erie to Head of Upper Rapids of Channel Above the Falls.

Goat Island and toward the Canadian bank, where it crosses the upper line of breakers. Before it reaches the Horseshoe Falls, this boundary line passes within about 135 feet of that part of the crest where the recession goes on at the most rapid rate, and where the water is supposed to be the deepest. This location of the boundary carries the territory of New York well out into the deeper part of the river; and an ample supply of water for the American Falls can be assured by excavating a new channel from a point near this line, down past the head of Goat Island, to or below Bath Island. Such excavation will simply bring the channel to and along the American rapids down more nearly to a level with the channel between Goat Island and the Canadian bank. When this is done, whatever water remains in the natural bed of the river will divide between both the American and the Horseshoe Falls. As it is at present, the lowering by several feet of the river above Goat Island, through the pending diversion of water into the tunnels, pipe lines, and canals of existing and authorized power plants, will lay bare the channel between Goat Island and the New York bank, and will destroy the American Falls, because the limestone bed of this channel lies some seven to twenty feet higher in parts than that of the channel which leads down to the Horseshoe. If not entirely destroyed by a reduction of several feet in the level of the upper river, the American Falls will be reduced to a pitiful dribble for the reason just stated, and also because the channel to these falls, while only 340 feet wide at a point a little below the head of Goat Island, spreads out to a width of 1,060 feet at the edge of the cataract. This means that an average depth of six feet across this channel at its narrowest point will give only an average depth of two feet of water on the crest of the American Falls, the velocity being the same in both places. On the crest of the Horseshoe Falls, the length of contour is 3,010 feet; while the width of the Canadian channel on a line with the head of Goat Island is some 3,700 feet, so that the average depth of water increases as it nears the cataract.

American and Canadian Falls Compared

With normal water level in Lake Erie, the height of the American Falls is 165 feet, while that of the Horseshoe Falls is 158 feet, at the water line. No doubt the water level in the Gorge is somewhat lower at the foot of the former of these two falls; but if this difference is taken as one foot, which is probably more than the actual amount, the crest of the American is still six feet higher than that of the Horseshoe Falls. While the sheet of water flowing over the American cataract is no more than three or four feet in thickness at its deepest points, the depth of water near the center of the Horseshoe Falls is known to be at least sixteen feet, because a vessel of that draught went over them some years ago. During the construction of the intake works of one of the great power plants in Queen Victoria Park, depths of water between 19 and 26 feet were found at points some 2,000 feet above the Horseshoe Falls and about 500 feet from the original shore line. This makes it probable that there is a depth of more than 16 feet along a part of the crest of these falls. Even with a depth of 16 feet at the Horseshoe, and as much as four feet of water at the American Falls, the shelf of limestone over which the latter flow must be some 18 feet higher than the corresponding shelf between Goat Island

and the Canadian bank. The lower elevation of the Canadian channel continues up stream, past the head of Goat Island and the first line of breakers, to the smooth water above the rapids, where the normal river level between the New York and Canadian banks is about 557 feet above tidewater. A little above the first row of breakers, on a line crossing the river near the head of Goat Island, and some 500 to 600 feet from the Canadian bank, the limestone bed of the stream is 13 to 16 feet beneath the surface elevation of 557 feet just named. On this same line the depth of water just above the entrance to the American

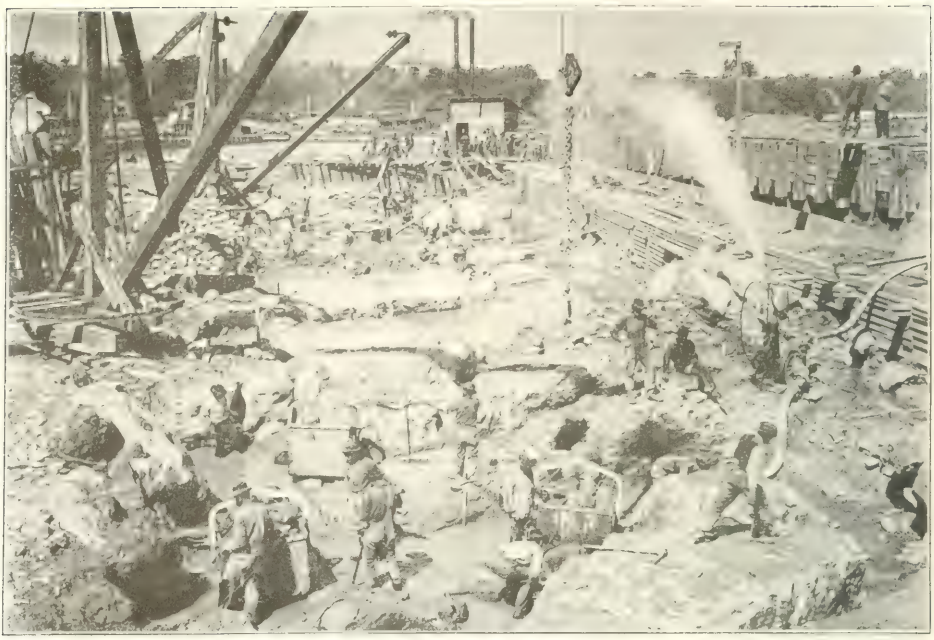
BED OF RIVER ABOVE HORSESHOE FALLS.
Laid bare through construction of a cofferdam.

channel is probably not more than five to six feet. From the surface elevation of about 557 feet, the river falls some 56 feet in the rapids above the Horseshoe, and about 50 feet in those leading to the American Falls. Much the greater part of this descent between Goat Island and the New York bank, occurs along the thousand feet of channel above Bath Island; and this fact makes comparatively simple the problem of excavation to ensure an ample volume of water at the cataract below.

Proposed Line of New Channel

One part of the deepened channel should run diagonally out into the river toward the international boundary line, from a point several hundred feet above the head of Goat Island; and the other part should extend from the point just named, down through the narrow neck that forms the upper end of the passage between Goat Island and the New York bank. These two parts of the deepened channel would meet at an angle of perhaps 30 degrees. Such an artificial channel 100 to 200 feet in width and of suitable depth would carry an ample supply of water for the American cataract as long as there was any considerable amount going over the Horseshoe Falls, even though the level of the upper Niagara river were so reduced that the natural channel between Goat Island and the New York bank would be laid bare above Bath Island.

It is worth noting, not only that no excavation would be necessary below Bath Island, but also that the greater elevation by probably as much as 18 feet of the rocky shelf of the American above that of the Horseshoe Falls would not prevent the delivery of an ample volume of water over the former. The reason for this is that the division of water for the two cataracts must take place above the head of Goat Island, where the surface elevation of the river is some fifty feet higher than the crests of the falls and after this division has been made, the relative elevations at the two falls cannot affect the results. The flow of water to the American Falls is now



EXCAVATING CANADIAN CHANNEL TO MAKE FOREBAY FOR ELECTRIC PLANT.

throttled by the high ledge of rock in the river-bed just above the head of Goat Island and in the upper part of the channel between that island and the New York bank. By the proposed artificial channel, this barrier of rock will be pierced, and the greatest menace to the preservation of the American Falls removed. With the upper river at its present height, the proposed artificial channel, after its completion, would be entirely covered with water; but when the upper river had been lowered several feet, so as to lay bare the natural channel between the head of Goat Island and the New York bank, the artificial channel near the center of the natural one would appear as a wide and deep canal running full of water for the supply of the falls below. A little above Bath Island this canal would end, and its water would spread out for its plunge over the crest of the American Falls.

If it were desired to maintain the present appearance of the American channel above Bath Island, the deep canal-like cut from a point in the river-bed near the international boundary line might terminate just above Goat Island; and then the natural channel might be deepened the necessary number of feet over the entire width of its upper part. From an æsthetic point of view, this is no doubt the better plan.

There can hardly be a question that the excavation here proposed would be entirely effective to preserve the American Falls, for whatever water rights may have been or may in future be granted along the Niagara river by New York and Ontario, it is not to be expected that capital would be invested in new power plants about the Falls to an extent that would drain most of the water out of the Canadian channel, as this would destroy the value of the three great plants in Queen Victoria Park. As long as there is a goodly flow of water down the Canadian channel, the proposed excavation on the New York side will ensure the preservation of the American Falls.

It may be objected that the excavation of the upper channel to the American Falls will cost, perhaps, a million or two of dollars; but this is a small price to pay for the privilege of developing a million or more of horse-power, and at the same time preserving these Falls in their original condition. In fact, for the grant of a single location and water

A HINT OF HOW THE FUTURE NIAGARA MAY LOOK.
Power houses, mills, and factories now standing along the lower river front.

right on the upper shore of Prospect Park, the State of New York could no doubt obtain an annual rental that would pay the entire interest on the investment necessary to make the proposed excavation.

Dry Niagara

That destruction of the American Falls is certain to follow a reduction of a few feet in the level of the upper Niagara river, in the present condition of the channel, has been proved by the actual happening of the event. In the winter of 1903-04, an ice-jam in Niagara river so reduced its level that the flow stopped over the American Falls, save as to a small stream between Prospect Point and the first projection along the crest. On February 14, 1896, the river was so low that no water passed over the crest of the American Falls between Goat Island and Luna Island, and the Cave of the Winds was laid bare. In November of the same year, the limestone bed of the river over a wide stretch above the Three Sisters Islands and adjoining the head of Goat Island, was exposed to view by the recession of the waters into the Canadian channel. Because of an ice-gorge at the foot of Lake Erie, in 1848, the American Falls came temporarily to an end.

It is time for instant action. Shall we wait until the sublimest spectacle in the United States is destroyed?

The Burton Resolution

In this connection, important legislative action has been inaugurated in Congress by the passage through the House of Representatives of a joint resolution looking to the preservation of Niagara Falls, introduced by Representative Theodore E. Burton, of Cleveland, Ohio, chairman of the House Committee on Rivers and Harbors, and now (Feb. 15) pending in the Senate. It will be remembered that by Act of Congress of June 13, 1902, an International Commission was created to arrange with the Dominion of Canada the method of controlling the boundary waters connected with the Great Lakes. The Commission includes three American members (two engineers and one lawyer), and three members appointed by Canada. The Commissioners have been considering the problems submitted to them for nearly a year, including especially the diversion

BED OF RAPIDS IN CANADIAN CHANNEL UNCOVERED BY COFFERDAM.
Water here was about twenty feet deep.

of the water for power plants, the exact boundary line between the United States and Canada, and the use of the navigable channels which pass from one side to the other of the boundary line. They have already considered the diversion of the water for power plants in Niagara river at the Falls. While their immediate jurisdiction has to do with questions of hydraulics alone, they have also had under consideration the danger of destroying the artistic beauty of the cataract, and it is believed they are all ready to recommend such measures as will put a stop to further desecration.

Mr. Burton's resolution calls upon the American members to make a report at an early day, of the best method to be employed to save the Falls from further depletion. It also directs them to use all possible efforts with the Canadian members to preserve them. Of course the Congress of the United States can direct only the three members from the United States; but it is thought that the Canadian members are equally favorable to any measures required for the accomplishment of the desired end. Eminent lawyers have expressed the opinion that the best method to preserve Niagara Falls from further injury is by international treaty between Great Britain (representing Canada) and the United States; and it is thought that this resolution will be an entering wedge to secure such a treaty or agreement.

When Life or Death Hangs on a Blood-Stain

How Science Sometimes Serves the Ends of Justice

By WILLIAM FRANKLIN WATSON

Expert in Microscopy, Furman University, Greenville, S. C.

IN cases of murder, stains supposed to be blood are sometimes found on the clothing or belongings of suspected persons. In doubtful cases of this kind, the fate of the defendant usually depends, not so much on judge, jury, or eloquent lawyers, as on the observations of a man who, quietly seated in his laboratory, is compelling with his microscope the invisible to become visible.

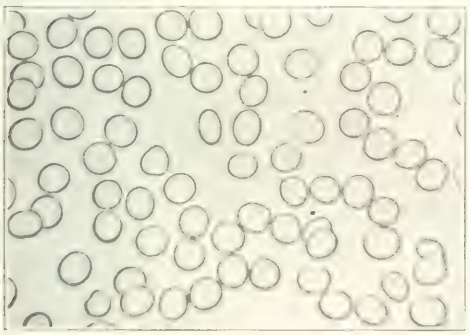


FIG. 1. HUMAN BLOOD-DISCS, LARGELY MAGNIFIED. Red, round, and not nucleated.

When the prisoner claims that certain dark red stains on his clothing were caused by spatters of red paint, the judge and the jury and the lawyers cannot prove or deny the statement. They may say: "It looks like blood." But what do vague resemblances amount to, since in so many of the affairs of life "things are not what they seem?"

A human life hangs in the balance. It must neither be sacrificed by vague suspicions, nor saved if the suspect is guilty. The man with a microscope and a laboratory is the only person who can settle the question, and he can settle it beyond the shadow of a doubt. He dissolves a particle of the stain in a drop of liquid, then spreads a minute fraction of this drop on a little slip of glass three inches long and an inch wide. Next he examines it with the microscope. If he sees a great host of little red discs, such as appear highly magnified in Fig. 1, he knows that the stain was made by blood.

But suppose the stain is old and has been exposed to the weather for weeks or months. It has become greatly changed. It can be dissolved only with difficulty; and the little blood-discs, if present, may be shriveled, distorted, and broken up, until it is impossible to determine whether they are real blood-discs or particles of something else. When the blood has reached this state, it is impossible to use any chemical which will restore the discs to their original condition. Consequently, it is frequently impossible to identify old blood by means of its discs. In such cases the investigator takes a particle of the stain on a glass slip, and dissolves it in strong acetic acid, adds a minute portion of common salt, and heats it with extreme care. Great skill is here required in order to heat just sufficiently and not too much. The glass slip is then examined with the microscope; and if a great number of stick-like, X-shaped (and occasionally

FIG. 2. CRYSTALS FROM HUMAN BLOOD. Stick-like, X-shaped, and occasionally star-shaped.

stellate) crystals appear, the stain is known to be blood. These are called "Teichmann's crystals" (from the discoverer). They are regarded by experts as yielding evidence which is absolutely conclusive. They can be produced by no known substance except blood. The crystals shown in Fig. 2 were made from stains found on the belongings of a man who was suspected of having committed a recent murder in South Carolina. The original photograph was made directly from the blood-crystals, by combining the microscope and camera. This picture

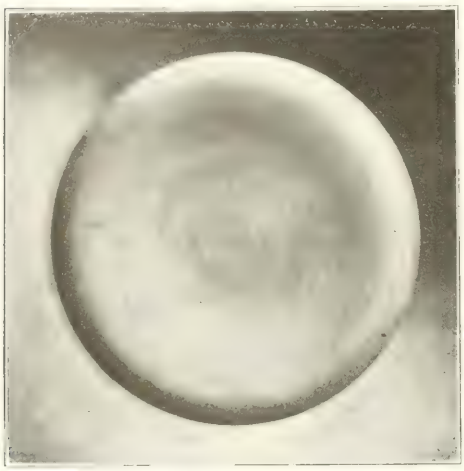


Fig. 3. Single Red Blood-Disc (Human). View from flat side, vastly magnified.

was admitted as part of the evidence for the State in the trial of the murderer.

Another important method for the detection of blood is that of spectrum analysis, which depends on its optical characters and requires more complicated apparatus than the other processes.

The fourth test which may be applied to blood is strictly chemical. A small portion of the suspected substance is put on clean, white paper, and is moistened with tincture of guaiacum. A drop of hydrogen peroxide is next added, when, the paper will turn to a beautiful blue color, if the substance tested is blood. A particle of blood which is scarcely visible to the naked eye may be detected in this way.

The human blood-discs, which are shown highly magnified, in the first picture, are very small. It would take 3,200

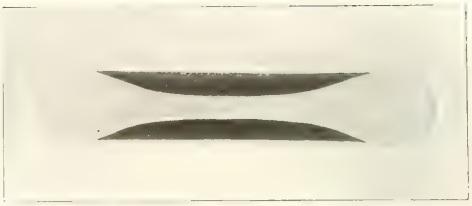


Fig. 4. Human Blood-Disc Cut Through Center. Showing appearance of cut edge.

of them placed side by side in a row, to measure one inch in length. Though very minute, they are so numerous that a volume of blood not larger than the head of a pin is believed to contain five millions of them. In fact, they are present in the blood in such vast numbers that some scientists have made the astonishing statement that if all the blood-discs which are in one person were arranged side by side in a continuous line, that line would be long enough to reach four times around the earth.

Fig. 3 shows a single red blood-disc (human) highly magnified, the view being taken from the flat side. Fig. 4 shows a similar blood-disc which has been cut through the center to show its structure. This view is taken from the cut edge. Fig. 5 shows an oblique view of the same disc. These illustrations show that a red blood-disc is thickest near the edges, and thins out near the middle, where the two concave sides approach each other. The surface part of a blood-disc appears to be somewhat firm, though flexible and elastic; and within it is a fluid which contains the blood-coloring matter.

Without discussing the differences be-

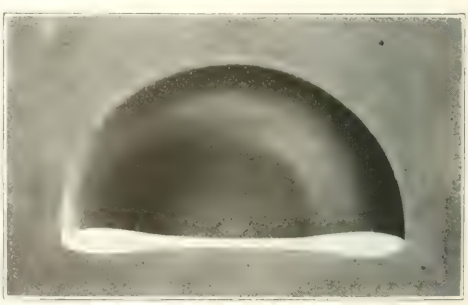


Fig. 5. Oblique View of Half of a Blood-Disc (Human). Vastly magnified.

tween blood from the veins and that from the arteries, and the differences in color as affected by the different substances on which it falls and dries, it may be noted that in general, when blood-stains are fresh, their color is scarlet and they dissolve readily in water. As the stains get older, they become darker, first changing to reddish brown and later to dark brown. They also become less and less soluble in water. Finally they become entirely insoluble in water, and chemicals must be used for their solution. From these facts it will be seen tests give exactly the same results, whether the blood is that of a man, a bird, or a reptile. Many suggestions for differentiation along this line have been made, which, however, would not stand the test of practical experiment in the laboratory; many fine theories have been advanced, only to be overthrown. So it must be acknowledged that up to the present time it has been found impossible by any other process or instrument to distinguish human blood-stains from those of other animals. But under favorable conditions, when the blood is fresh,

FIG. 6.

FIG. 7.

BLOOD SPATTERS.

In both cases, drops fell long distance, striking in case of Fig. 6 at right angles, and in case of Fig. 7 obliquely.

that the analyst can, under favorable conditions, determine the age of blood-stains. He cannot be exact in his conclusions, it is true; but he can say whether the stain is a few days old, a few weeks old, or a year old.

By the examination of a blood-spattered surface, one does not need to be a Sherlock Holmes to determine pretty accurately the direction of fall of the drops and the distance from which they came. Figs. 6 and 7 show different kinds of spots and spatters produced by blood drops striking a surface at different angles.

An important question arises. After determining that the stain is blood, can the investigator decide whether it is human blood or the blood of a beast? In deciding this question, he must rely entirely on the microscope. All chemical the microscope will give results which are satisfactory and reliable. The blood-discs of birds and reptiles are oval and nucleated, while human blood-discs are circular and have no nucleus. The blood of pigeons and frogs, as shown in Figs. 8 and 9, may be taken as types of blood of birds and reptiles. By comparing the discs in these pictures with the human blood-discs in Fig. 1, the contrast is readily observed. Therefore, if a man who is arrested for murder claims that certain stains on his clothing were caused by killing a chicken, a reptile, or a fish, the microscopist can easily determine the truth or falsity of the statement.

The camel and llama have oval blood-discs like those of birds and reptiles; but all other higher animals classed as mammals have circular blood-discs closely resembling those of human blood. In fact,

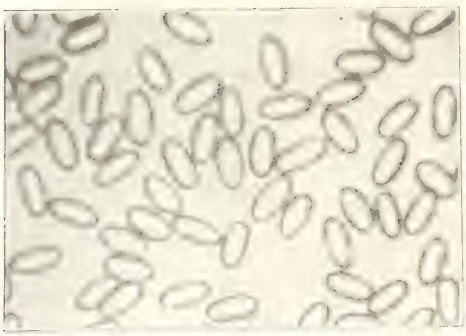


FIG. 8. BLOOD-DISCS OF A PIGEON
Oval and nucleated.

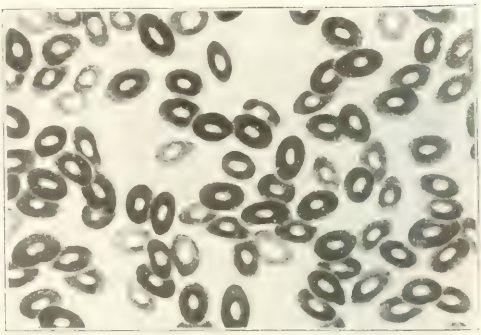


FIG. 9. BLOOD-DISCS OF A FROG.
Oval and nucleated.

the resemblance is so close that the only way of determining the difference is by measuring the discs. For this purpose, exceedingly delicate instruments are used in connection with the microscope. The blood of sheep, goats, horses, and cattle has discs which are considerably smaller than those of human blood. But monkeys, dogs, rabbits, and guinea-pigs have blood-discs so nearly like those of man that it appears doubtful if it is possible for any scientist to decide positively between them.

It has also been found impossible to distinguish the blood of a man from that of a woman or a child, or the blood of any one person from that of another, under any ordinary circumstances. Notwithstanding the limitations mentioned, the specialist has, in very many cases, rendered eminent service in the identification and conviction of criminals.

EFFICIENCY

EFFICIENCY is the practical underlying principle in the work of technical education. In no other walk of life is actual efficiency so essential as in engineering. In other lines there is a place for the student, for the theorist, for him who would turn to his book to gather wisdom, but not so in technical work. Here there must be the man to do — to take those great and mighty forces and make them do effective work. Unless he can so stand up and do that, the engineer cannot succeed.–WILLIAM BARCLAY PARSONS.

SKEE-RUNNERS IN THE HIGH ALPS

HOW SOLDIERS MARCH AND CIVILIANS AMUSE THEMSELVES

BY

FRITZ MORRIS

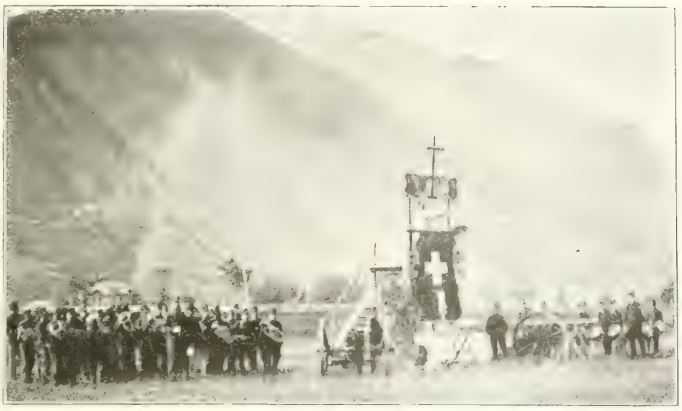
YOU sit comfortably in your hotel at Chamonix, and look up towards the white, stupendous summit of Mont Blanc towering in awful majesty nearly three miles into the clouds. With the naked eye you see what looks like a colony of small, black ants, clinging precariously to the side of the mountain more than half-way to its invisible top. Looking through the hotel telescope, you make out that the ants are men, traveling in regular order and at surprising speed over a field of apparently freshly-fallen snow.

"It's a company of our Alpine troops," explains your French landlord. "They are out on skees, manœuvering for position. There are other companies also out on the mountains, and the game is to see which shall get command of the pass. On skees and in deep snow, they can make their thirty or forty miles a day."

Across the Alps, on the southern side, the Italian *Bersaglieri* are quite as expert as their brethren of the French mountain troops. They, too, are given weeks of practice marching through the snow-filled mountain passes, making fast time on their skees and pulling mountain rapid-fire guns up to heights that seem entirely inaccessible. But French and Italians are children in skee-running when compared with the Swiss and Norwegians, to both of whom the long, slender, wooden skees are familiar from the time they are able to walk.

MOUNTAIN TROOPS WITH PORTABLE TELEPHONE APPARATUS.

COMING DOWN THE STEEP SLOPE OF THE BIETSCHHORN, VALOIS.



TEMPORARY ALTAR, WHERE AN ALPINE REGIMENT WORSHIPS.

In Switzerland, the playground of Europe, men, women, and children are trained in the use of skees. Classes are organized in all the schools, and none but those physically unfit are excused from attending them. When, on the famous skeeing course at Grunewald, or the beautiful slope of the stately Jungfrau, one sees a Swiss expert dashing down over the icy surface at the rate of fifty miles an hour, then suddenly leaping high into the air and alighting in safety more than 100 feet away, it is easy to understand the fascination of the skees.

In Norway practically all the regular troops are trained skee-runners, and, had not the recent threatened struggle with Sweden been happily averted, the world would have seen the advantage to an army compaigning in a mountainous and snow-covered country.

In both Norway and Sweden the mails are carried into remote and dangerous parts of the mountain country by postmen who travel on skees. One Norse postman recently made a record of sixty miles in a single day, much of the distance over a terrain where a single slip meant a broken leg, at the least.

In both the Scandinavian countries, great national, outdoor, winter *fête* days are celebrated, with skee-running and jumping as their chief features. On the first Sunday in February, when the snow is usually in its best condition, an annual "skee" competition is held at Holmenkolen, near Christiania, Norway, and famous races are held, and "jumps" made. A leap of 200 feet has been re-

WHERE THE MOUNTAIN TROOPS FIGHT PRACTICE BATTLES.

ANSWERING THE SIGNAL FROM THE VALLEY BELOW.

corded. At Holmenkolen, on *fête* days, beginning before dawn, people make their way from the city and all the surrounding districts to the meeting-place; and at one o'clock, the time for the leaping to commence, vast crowds congregate on the ice and surrounding points, from which a view of the hill can be obtained. The scene is then an animated one, picturesque from the rime-coated and snow-laden pines, the pure white snow, and the moving mass of humanity; the women folk in all varieties of colored head-gear, and dresses of gaudy tints; the girls, who wear dark flannel dresses cut well above the ankle, with bright-colored waist-belts and scarlet, knitted, worsted caps giving color to the frozen landscape. The long braids of golden hair mark their northern origin; and the thick-soled shoes and broad-ribbed stockings, their ignorance of the fashionable shoemaker.

The running track lies on the face of a hill rising from a frozen lake to a height of nearly 160 feet. The length of the track, on the slope, is 190 yards; and the "hop" or platform from which the leap is taken, is located about two-thirds of the way down. The angle of the hill above the "hop" is about fifteen degrees, and that of the lower portion twenty-four degrees; and the time occupied in descending from summit to base, when the snow is in perfect condition, is about fifteen seconds. On a recent occasion one man, a noted jumper,

SKEE-RUNNING FOR SPORT ON A NORWEGIAN MOUNTAIN SLOPE.—THE FINISH.

SKEE-RUNNING FOR SPORT ON A NORWEGIAN MOUNTAIN SLOPE.—THE START.

Olaf Tandberg, made a grand leap of 102 feet—the longest on Holmenkolen track—but fell. The best "standing jump," by which is meant one in which the man keeps his feet on alighting, and continues to the end without falling, was made by Leip Berg, who covered 93 feet. On such a day the falls, as might be expected, were numerous. During the first run, in which 140 men took part, only sixty-four kept their feet after leaping.

Of recent years, skee-running has become popular in Canada and in all those parts of the United States where sufficient snow falls. As a sport, it is fascinating and thrilling beyond most others. During the last winter several competitions were held in the Northwest, where Swedish and Norwegian settlers are plentiful; and a large league of skee-clubs has recently been organized, with headquarters in Chicago, Ill. It, in turn, will pay allegiance to the National Skee Association, which has been in existence for some years.

Nansen, in his "First Crossing of Greenland," describes skees as "long, narrow strips of wood—those used in Norway being from three to four inches in breadth, eight feet, more or less, in length, one inch in thickness at the center under the foot, and beveling off to

SIGNALING TO A DISTANT MOUNTAIN TROOP.

RESULT OF LOSING BALANCE ON SKEES.

about a quarter of an inch at either end. In front they are curved upwards, and pointed; and they are sometimes a little turned up at the back end, too."

There are almost as many kinds and styles of skees as there are of shoes. A pair for children—four feet long—can be bought for two dollars. Handsome skees ten feet long, with grooved palms, adjustable straps, and rubber foot-rest, will cost about ten dollars; and fancy skees, with patent foot-rests and horn or sealskin mountings, twelve to fifteen feet in length, cost twelve to twenty dollars a pair. The latter are used by skee-champions, who spare no expense to secure a real or fancied improvement in their runners. The ten-foot skee at ten dollars is the most serviceable and the kind most generally worn.

Wood of the lightest and toughest kind is used for making skees, ash and pine or oak being the most popular. The skee may be perfectly smooth and plain, or grooved to prevent side-slipping. If the skee is intended for rough usage, it will be strengthened by plates of horn; but for traveling over soft, loose-packed snow, sealskin is the ideal covering. The feet rest upon the centers of the skees, to which they are attached. But whichever construction is adopted, two require-

A COMPANY OF ALPINE TROOPS ON SKEES AND SNOWSHOES.

MOUNTAIN TROOPS ABOVE THE CLOUDS.
Commanding officer reading the orders of the day.

ments are absolutely imperative—first, that the heel shall move freely up and down; second, that it shall be possible to withdraw the foot instantly. Upon the latter condition life itself may depend.

The skee-runner is equipped with moccasins of soft leather, and with a long pole having a wide leather washer a short distance above the lower end, to prevent it from sinking too deep into the snow.

When Three's Company

THE wind howls 'round the house;
We hear it swell and die,
We three, shut in together,
Fearing nor wind nor weather,
Just you and Love and I.

Life's bitter storms assail,
The winds of Fate blow free,
We closer draw together,
And there's nor wind nor weather
For you and Love and me.

PAULINE PARKER CARROLL in *American Magazine*.

OVERHEAD CONSTRUCTION ON LINE OF BLOOMINGTON, PONTIAC & JOLIET SINGLE-PHASE ELECTRIC RAILROAD.

Alice and the Alternating Current

Professor's Pretty Young Wife Gets the Latest Information About Electricity As Applied to Railroad Service.

By GEORGE C. HAWKINS

That alternating current will be used generally on our main railway terminals, and ultimately on our main through lines, for passenger and freight service, I am convinced; but I do not expect that the change from steam to electricity will be made for economic reasons, or that it will be made voluntarily by the railroads.—BION J. ARNOLD, Past President American Institute of Electrical Engineers.

For an interview with Mr. Arnold on this subject, see page 195.

"JOHN," said the Professor's pretty young wife, "the papers are all telling about some new electric invention that's going to haul all our railroad trains. I wish you'd explain it to me. I think it's a wife's duty to understand her husband's work, don't you?"

The Professor looked about him vainly for some way of escape. Then he cleared his throat desperately.

"I suppose," he said, "that you refer to the commutator-type, single-phase, alternating-current electric motor."

I got in just in time to catch my sister Alice—the Professor's wife—as she tipped over backward off her chair. John—the Professor—was at her side almost as soon as I.

"What have you done to her?" I demanded.

"Nothing at all," stammered the frightened man. "I was just starting to tell her about the commutator-type, single-phase, alternating-current motor—that's all."

"Well, no wonder she fainted," I said, with a smile of relief. "You shouldn't be so brutal."

The Professor looked at me with

pained eyes that did not at all comprehend. Just then Alice recovered consciousness again.

"John," she whispered, faintly. The Professor crept noiselessly near, and bent over her.

BION J. ARNOLD.

Past President American Institute of Electrical Engineers. A Pioneer in the Application of Electricity to Railroad Service.

"What was that you said, John?" she gasped.

"The commutator-type, single-phase"—he began, but I interrupted him, savagely.

"Not another word," I commanded. "Alice," I went on to my sister, "when you are strong enough to listen, I'll tell you all about it myself."

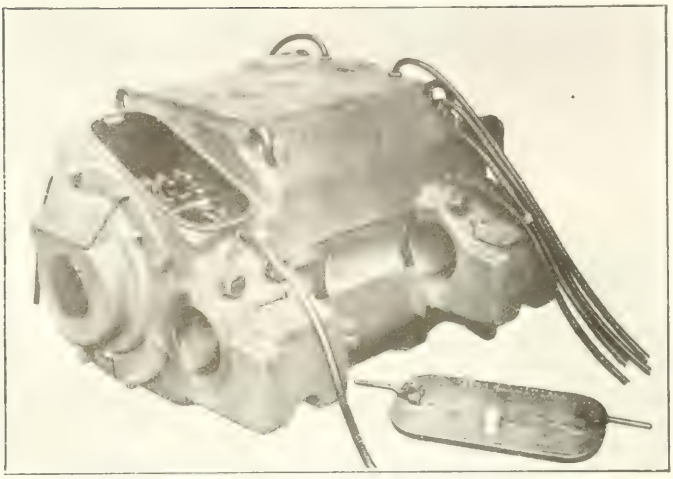
Is a Wife's Duty

"But don't you think," said Alice, "that a wife ought to be able to fully understand her husband's work? I don't like to be treated like a baby and have everything translated into words of one syllable for me."

"That's all right, Sis," I said, with an insolent look at the Professor—he needs a taking down occasionally. "But you see, in this case, the husband don't understand very much about it himself."

"He does, too," Alice burst out, indignantly. "John is one of the leading electrical engineers of the United States. You can just look in 'Who's Who.'"

"O yes," I answered, patiently. "He knows as much as any of them, I know that. But there isn't a single one of all these wise men who even knows what electricity is. And they are all in a conspiracy to hide their ignorance by using a lot of big, high-powered four-syllabled words in talking about it."



SINGLE-PHASE ALTERNATING-CURRENT ELECTRIC RAILWAY MOTOR.

The Professor started to say something about scientific accuracy, but I shut him off quickly.

"Come on, both of you," I said, "and take a ride with me on the long-distance trolley. The way to really understand a thing is to go and look at it. And besides, Alice, the fresh air will do you good."

* * * * * * *

As soon as we passed the city limits, the car struck up a forty-mile gait, and we began to rush through the flat, green, farming country with the speed of a railroad train.

"Look at the funny way they have of propping up the trolley poles," said Sister Alice, as we sped along. It was plain she was determined to show herself very observing.

"She evidently alludes to the insulated guy-wires," said the Professor to me. Alice looked a trifle hurt.

"That wire doesn't exactly prop the pole up, dear," explained I, "though if it wasn't for the wire the pole might easily be blown down. Do you see how the wire is patched together, with a long piece of wood between its two ends?"

"Why, yes," she answered, brightly. "I wonder why they don't use wire all the way up, instead of putting in a piece of wood that way?"

"That piece of wood has saved the life of many a cow," I declared, and saw at once that Alice thought I was laughing at her. "If it was all wire, you see, the current might run down—in case of an accident to the transmission wires—and kill any animal that touched it. The wood acts as an insulator and makes the current stay up above on the wires intended for it."

"Dear me!" Alice broke out again a few minutes later, "if they haven't got two trolley wires on this queer road!"

"That system of wiring," said the Professor, with an evident effort to be simple and easily understood, "serves a purely mechanical purpose. It has no electrical significance whatsoever."

"He's right—as always, Alice," I put in. "On a single-track road like this they use two smaller trolley wires, instead of one big one, so that when two cars meet and pass, each of them can use one of the trolley wires, and it isn't necessary to put up a lot of expensive overhead switches and other contraptions at the turn-outs. All the cars running West use the North wire, and coming East they use the South wire, as you will see if you keep your eyes open.

DOUBLE CATENARY OVERHEAD WIRE CONSTRUCTION, WITH BRIDGE SUPPORTS.

Alice is Observing

"What are those little two-storied brick houses built alongside the track every few miles?" asked Alice presently.

"Rotary converter substations," burst out the Professor, before I could get in a word.

"Never mind, Sis, what they are, just now," I said. "Look at the next one we run by, and you'll see a couple of workmen about and a lot of expensive machinery inside. Up to this time, trolley companies have had to build one of these houses every few miles along their tracks. And it costs a lot of money to pay the wages of the men and keep the expensive machinery running properly. Now the big electric companies have invented a new way of hitching up lightning to street-cars, which does away with the necessity of building these little houses and hiring all these men. That's the chief reason why the newspapers say the steam locomotive is going to be knocked out."

ALTERNATING-CURRENT MOTOR CAR ON BALLSTON LINE, SCHENECTADY RAILWAY COMPANY.

* * * * * * *

"Electric current, my dear," the Professor began, in a most patronizing way, "is of two kinds—direct and alternating."

I hastened to interrupt before he unleashed any more knowledge.

"Yes," I said. "If you'll imagine a stream of water running straight along through a pipe, you'll get a conception of what the direct current is like."

"Very unscientific," growled the Professor under his breath.

"And then," I went on, without noticing him, "if you'll picture the same stream of water running to the end of the pipe and then turning round and running back again—making the round trip about twenty-five times a second—you'll have an idea of the alternating current."

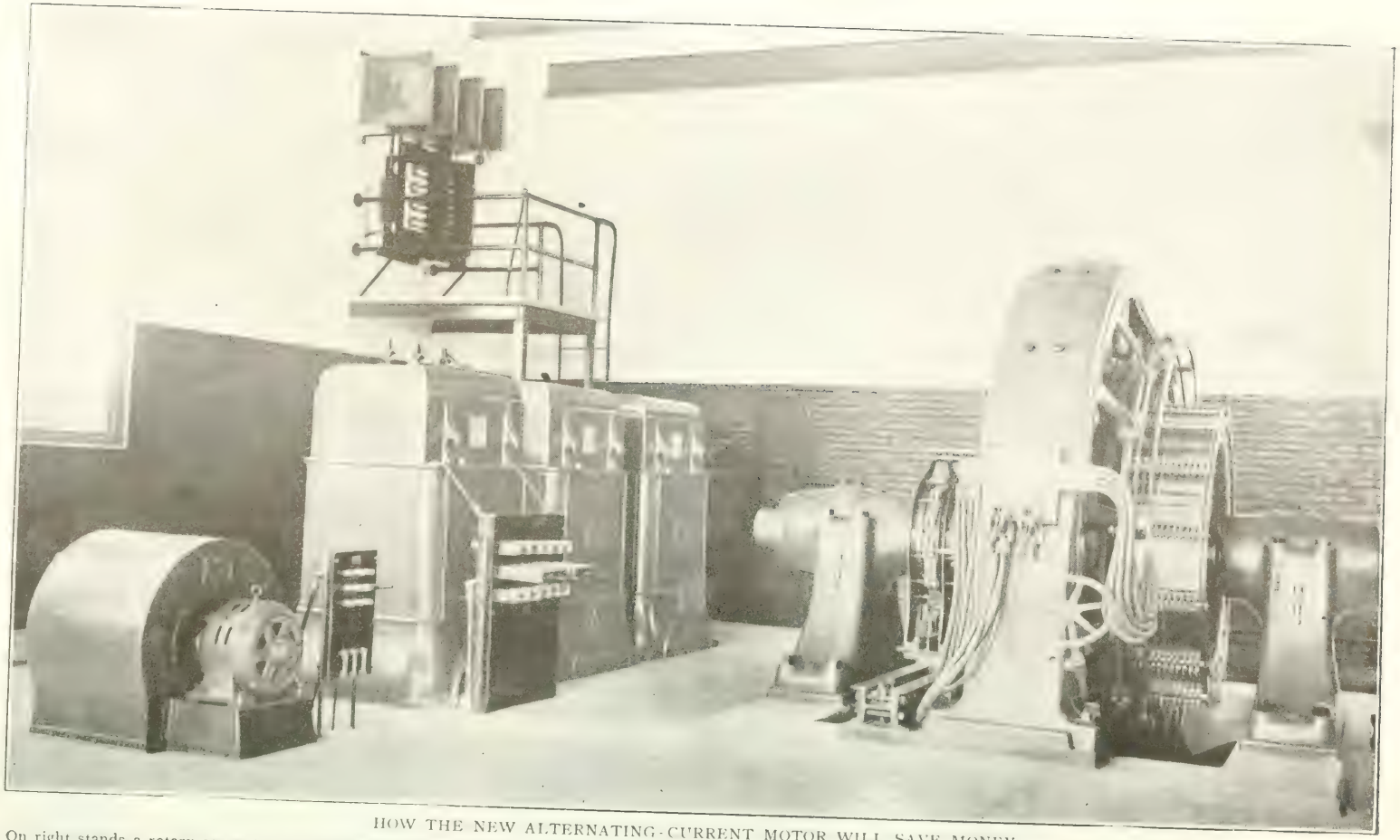
"Perfectly absurd and inaccurate!" sneered the wise man.

"The direct current is electricity tamed, so to speak, easily handled in captivity, broken to eat out of the hand," I said. "The alternating current is a fast and dangerous young man, almost ready to follow the example of its wicked stepfather, the flash of lightning."

Professor Shows Contempt

A sniff of contempt from the Professor. "You might at least," he said, "point out the fundamental difference between the two kinds of current as ordinarily used. The direct current, for example, has large strength and low voltage. The alternating——."

It was cruel, but I felt it my duty to stop him before he got wading over his



HOW THE NEW ALTERNATING-CURRENT MOTOR WILL SAVE MONEY.

On right stands a rotary converter, a complicated and expensive machine requiring the almost constant attendance of two highly paid and skilful men. On left are three static transformers, comparatively simple and cheap machines, containing no moving parts whatever and requiring practically no attention. When Direct-Current motors are used on long-distance roads, an equipment like that shown in the photograph must be located in substations, built alongside the tracks at intervals of a few miles, thus entailing large expense for investment and maintenance. With the new Alternating-Current motor in use, the huge rotary converter is no longer necessary, and is entirely done away with, leaving only the simple and practically automatic transformer.

knees in the quicksands of professional verbiage.

"Exactly," I broke in. "I was just about to explain. Think about that water pipe again, Alice, and picture a large flow of water being forced under low pressure through a pipe of large diameter. That's the direct current. Now imagine a small flow of water being forced, under high pressure, through a pipe of small diameter. That's the alternating current."

"Misleading!" snorted the Professor. "Utterly unscientific!"

"Well, Sis," I went on, "this trolley car and almost all the trolley cars in the world are now run by motors that will take only the direct current. The direct current—that's the big stream, you remember, running under low pressure through the large pipe—has to have a big, fat, copper cable to travel over. Copper is expensive. And, worse than that, the large direct current has a way of wasting its strength by heating up the copper cable it travels over; so that, at the end of a fifty-mile cable, for instance, there wouldn't be much power left. So the direct current isn't any good at all when you want to haul a trolley car a long way from the power houses.

What is Alternating Current?

The Professor looked at me, pityingly.

"The alternating current, on the other hand—the little stream running back and forth under high pressure—will go whizzing out as far as you please over a little, cheap, copper wire; and it feels just as strong, thank you, at the end of a fifty-mile run as when it started out."

"That's three-phase alternating current wiring up there now," the Professor threw in, pointing up to the three little copper wires that ran along the side of the track we were traveling over.

"O dear!" Sister Alice said, almost pettishly, "What on earth do you mean by 'three phase'? And why do they use three wires, anyhow?"

The Professor barely suppressed a scornful laugh, and I was glad to see that his wife glanced at him sharply.

"He does talk like a twelve-volume encyclopedia," I said, emphatically, "but he can't help it. Three wires are used because they are necessary to carry three-phase current, and that current is used because the machinery required to handle it is simpler and less costly than that required by other kinds of current. A three-phase current is simply three single currents, each starting from the power-house an instant later than the one before it.

"You know, Alice, every electric current must have a complete circle or circuit to travel over. It goes out on one path and comes home on another. If there's a break anywhere it won't go at all. Now, for a single-phase current you must have two wires, No. 1 and No. 2. On the first it runs out; on the second it comes back home. Now, by adding wire No. 3 you can supply paths for three currents. One will travel out on No. 1 and home on No. 2; a second out on No. 2 and home on number 3; and a third out on No. 3 and home on No. 1."

ROTARY CONVERTER STATION AT REDKEY, INDIANA

Poor sister Alice looked sadly puzzled and I hastened to make her forget her troubles.

"I just told you they couldn't carry the direct current very far because it loses its strength; so it has always been necessary to use the alternating current on the transmission wires of long-distance trolley lines. So John is right

SHOWING BOW TROLLEY USED ON SOME AMERICAN ALTERNATING-CURRENT RAILROAD LINES.

when he says those three wires up there carry alternating current. And I was right, too, when I said the motor on this car can use only direct current. That's where the little brick houses along the track come in. Watch now, and you'll see those three little wires run down and into each of the little houses."

Rotary Converter Substations

"They are rotary converter substations," the Professor repeated, firmly.

"Yes," I said, "that's their official title. It's their business to take hold of the alternating current, straighten it out, make it run in only one direction, and deliver it onto the trolley wires as nice, gentle, direct current, which the car motors can easily handle."

"But how do they change the current in that way?" asked Alice. "What happens to the electricity, anyway?"

"One way to change it is to make the alternating current from the three little wires turn a motor and make the motor, in its turn, drive a machine which will generate direct current. But in the rotary converter they have combined the two machines and the current that flows in as alternating comes out as direct, in something the same way as apples dropping into the top of a mill, run out as cider at the bottom."

"You see, Alice," I went on, "they have to use alternating current at high pressure to bring electricity a long way from the power house; and then they have to reduce its pressure and change it into direct current so that the motors on the cars can handle it. I hope that's plain."

"Yes," said the poor girl, but I fancied I still saw a puzzled look in her blue eyes. "It is dreadfully—interesting," she concluded lamely. I think "complicated" was what she really meant.

"The new invention," I went on, "is a motor which uses the alternating current directly, and so makes it no longer necessary to have all these brick converter houses and the workmen to attend them. That cuts off a great expense."

"I think," said the Professor, loftily, "you would better say something about the transformer substations which it is still necessary to use."

Taking Off Pressure

"Well, Alice," I continued, "the higher pressure you put on the alternating current—the small stream running through a little pipe—the less power is lost on a long journey. So, the current on the wires leaves the power house at a much higher pressure than that at which the new alternating-current motors can use it. Thus, under the new arrangement, the current from the three little wires is run into machines which reduce the pressure and which deliver the current to the trolley wire at the proper pressure. Electricians call this reducing the pressure "stepping down" the voltage. By the use of the proper "transformers," the pressure of a current can be "stepped" either down or up.

"I'm afraid that isn't very clear," said Alice, pensively. Then she went on, with that irresistible smile of hers: "But, perhaps you'd better not try to explain it to such a stupid as I am."

"O, my dear," I reassured her, "the machine that does the 'stepping up' and 'stepping down' is really about the simplest thing in the whole business. Just imagine a square iron picture frame. Wrap some copper wire one hundred times around one side of the frame, just as you'd wrap string around a stick. Then wrap copper wire of ten times the area ten times around the opposite side of the frame and you've got one of John's static transformers 'all ready to do business.'"

"Is that all?" Alice broke out.

"Yes. All you've got to do is to hitch up the ends of the wire that's wound one hundred times around the frame to the three high-pressure wires, carrying current at, say, 11,000 volts pressure, and you'll get ten times as much current at 1,100 volts off the opposite wire, which is wrapped ten times around the frame. That's 'stepping down' the current. If you want to 'step up,' simply hitch the three wires to the wire that has ten wraps, and you'll get one-tenth the current with ten times the pressure off the other."

Professor Uses Some Language

"The transformer substations, which it is necessary to use with the alternating current, are comparatively cheap and cost almost nothing for attendance; while each rotary converter had to have a couple of well-paid workmen in almost constant attendance. That's where the big saving comes in."

All about the Starting Torque

"If," said the Professor, "I were attempting to explain the advantages of the new commutator-type, single-phase motor, I should certainly be careful to point out that its starting torque is equally as large as that of the direct-series motor, while, so far as speed regulation is concerned, it is far in advance of its older rival."

I looked at Alice with a grin on my face, but her eyes were fixed on the Professor. The look in them said as plainly as words: "What a marvelous man he is!"

"Please forget it, Sis," I said, "and listen to me while I tell you what the wisdom-clogged John thinks he is saying. There's the 'starting torque,' for instance. Suppose two men are trying to lift a heavy weight. A big, brawny, strong man takes hold of the weight; and by a slow, gradually-increasing effort he easily lifts it. You might say that his starting torque was large."

"Pooh!" snorted the Professor.

"While, if a little, nervous man—no

BOW TROLLEY USED ON OBERAMMERGAU ALTERNATING CURRENT LINE.

matter how strong—took hold of the weight with a sudden jerk, or a series of them, he'd have difficulty in making it budge. His "starting torque" would be small.

"The starting torque of a car motor is the power it has of taking hold of a heavy load and starting off with it easily and without jerking. The direct-current motor now in use and the new alternating-current motor both have large starting torques."

Overhead Construction on the Oberammergau Alternating-Current Railroad.

"And what," asked Alice, with a fine show of interest, "do you mean by variable speed?"

"Part of the time your horse walks, part of the time he trots, and occasionally he gallops. He is, so to speak, a three-speed motor. Now, in the direct-current motor equipment ordinarily used there are only two economical running points—one full speed, and the other half-speed. In between a dead stop and half-speed you are taking about as much power off the trolley as when you reach half-speed, but a good deal of it is wasted by being run through a resistance coil, which is simply heated up by the extra power. After you pass half-speed, you take enough power off the trolley to run you at full speed, and simply waste the power which is not needed to make the speed you are running at.

New Single-Phase Motors

"With the new single-phase motor in use, you take only just so much power off the trolley as is actually needed and used up in running the car; none of it is wasted. See?"

"Well," said Sister Alice, doubtfully, "I—guess—so."

"Then," said the Professor, beamingly, "with the alternating current in use, there is no danger of electrolysis."

Alice started up, and looked out of the car window apprehensively. "Is there now?" she asked.

"Not to us," I answered. "But there's no telling what damage electrolysis may be doing to gas and water pipes under the ground, and even to the steel skeletons of the sky-scrapers in big cities."

"What is it, anyhow?" asked Alice.

"Well, you see, the electric current is something like a small boy. It travels out from the power house on the trolley wire and is supposed to come back home again on the rails. But sometimes it runs away from the rails, and goes rambling off along the water pipes and other iron and steel pathways. Under certain conditions it takes atoms of iron away with it from the pipes and girders it visits, and leaves them somewhere else along the way. And so, in course of time, pipes or girders may be greatly weakened—even entirely ruined."

Is the House in Danger?

"Goodness," said Sister Alice, "our house has a steel frame. I wonder if it's in any danger of falling down."

The Professor smiled pityingly.

"Now, with the alternating current, there is no such danger. The current runs away from home just the same, and sometimes picks up atoms of iron and steel that don't belong to it; but, you remember, the alternating keeps traveling backward and forward along the same path. So, when some of the runaway current gets back home with stolen iron in its possession, its mother says: 'Now, Johnny, you've been taking

what don't belong to you. Run right straight back, and put that iron where you got it.'"

The Professor groaned, as if he were suffering awful agony.

"What's the matter, John, dear?" Alice asked in wifely alarm.

"How long is this fool brother of yours going to keep up this idiocy?" he demanded.

"F-r-free-port-t!" yelled the conductor, sticking his head into the door. "Far'sw'go! All out!"

"Well, Alice," I said, "I hope you've enjoyed the trip."

"O, very much!" she answered. Then, as we walked along, she turned to her husband. "John," she said, "I've got a sort of headache. Let's go and eat some ice-cream. I don't know when I've learned so much as I have this afternoon."

Blessed—then Cursed—by Water

How the Colorado River Brought Prosperity and, Later, Partial Ruin to the Weird Salton Desert

By EDGAR F. HOWE

IN one respect it is unfortunate that the wild, parched, barren wilderness in southeastern California, variously known as the Colorado Desert, Salton Sink, and the Imperial and Coachella valleys, is being populated and is becoming green with the verdure of a thousand farms. Time was, but a few years ago, when every writer of weird fiction in the far Southwest felt licensed to locate here the scene of his most picturesque fabrications.

Here it was, on the lower Colorado river, that "Captain Smith" found the lame turtle, and so won its gratitude by healing it that it returned in later years and offered its services as an animated ferry when the Captain was on an island threatened with a rising flood.

On yonder mesa, sloping upward from Volcano Springs, is the "invisible city," where the clangor of street-car bells and all the hubbub of a metropolis can be heard, but where only the gravelly soil,

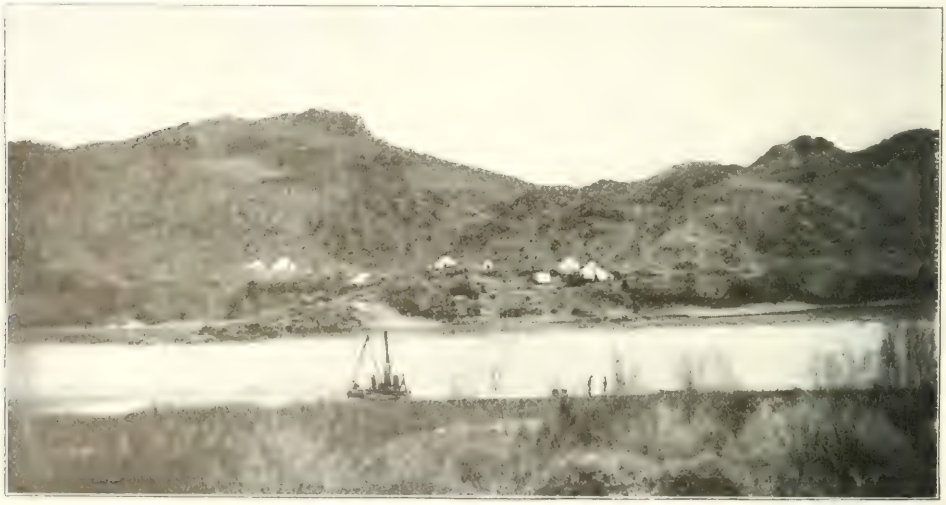
FIELD ON DESERT BEING IRRIGATED FOR FIRST TIME.

COLORADO RIVER NEAR WHERE IT EMERGES FROM ITS LAST CANYON.

the dreary mountains, and the scant, dwarfed vegetation can be seen.

Near Superstition mountains is the spring of natural gin, where the coyote, the gray wolf, the fox, and the wild fowl are on perpetual debauch; and near by is the hill from which flows natural ink. In the same vicinity is the mine of crystals which make perfect pens, and the deposit of asbestos where one can tear off sheets of blotting paper ready made.

It was in the Superstition mountains that Otto Schmidt found the invisible serpents with glass cups on the tails that revolved and produced beautiful music. It was in this desert, too, that an ingenious Yankee found a group of camels, abandoned in early days by the Army,



CAMP OF GOVERNMENT RECLAMATION SERVICE, WITH DIAMOND DRILL.

View taken near dam site on Colorado River, in vicinity of Bull's Head, Arizona.

IMPERIAL MAIN CANAL.

and, by syphoning the water from their sacks, was able to irrigate a farm, while the animals plied back and forth between the river and the farm, ever keeping up the water supply.

Wonderland of the Colorado

Now that about 8,000 persons reside on the desert, no one can build an artistic lie and connect it with this country without the same danger of exposure he would meet elsewhere, and consequently literature must forever be deprived of further developments along this line.

But though losing in this way, possibly we may gain something more valuable by seeking after truth, for there is no region where the creative factors of nature have worked more marvelous results, and no land where they have left a more legible record of their procedure. These transcripts of nature's message are really more than any fancy of fiction could be, even if it was made true.

The Colorado Desert is not rightfully a marvel simply because it is 265 feet below the level of the ocean at the west point. The whole Christian world has been familiar with the Dead Sea of Palestine for centuries, but there is not one person in a thousand who knows it is 1,292 feet below the level of the sea. Nor are these the only two points where great depressions exist; but because people are not familiar with them, these spots seem unaccountable.

The Gulf of California is a narrow arm of the Pacific in the neighborhood of 1,000 miles long. It cuts off from the mainland that Mexican possession known as Baja (or Lower) California.

Formerly the Colorado river flowed

PLOWING UP SALT AT LOWEST LEVEL OF SALTON SINK.

SITE OF TOWN OF IMPERIAL IN 1900.
Characteristic desert. No residence within fifty miles.

into the Gulf on the east side at a point about 100 miles below the extreme point of the sea's arm.

It is the habit of rivers to bear to the sea in suspension a certain amount of earth or silt, and deposit it when the flow is checked by the still water. The Nile, the Euphrates, the Tigris, the Ganges, and the Mississippi are well-known examples of this.

But no other river has accomplished such a task as the Colorado. Through that high plateau in northern Arizona known as the Coconino plain, the shrinkage of the earth's crust has caused the most marvelous rent in the surface of our globe.

The Grand Canyon

The Grand Canyon of the Colorado is some 300 miles long, ten to twenty miles wide, and a mile deep.

In the making of this stupendous flaw in the earth structure, probably 5,000 cubic miles of rock were powdered and borne to the ocean by the laborious water of the turbulent Colorado. This is aside from any solids the water may have acquired from other sources. In 5,000

SUN-DRYING OF FRUIT IN SOUTHERN CALIFORNIA.
A typical development resulting from irrigation.

MAIN STREET OF IMPERIAL AT PRESENT.
Population, 1,200.

cubic miles of earth there are about 750,000,000,000,000 cubic feet.

Creating the Desert

At the present time the Colorado river carries about one-half of one per cent solids, getting its name (Red) from the color of the soil in suspension. It is estimated that the solids carried past a given point by this river amount to 200,000 cubic feet a day on an average, or about 75,000,000 cubic feet a year. This is doing some work, but at this rate it would have required about 10,000,000 years for the river to carry away 5,000 cubic miles of powdered rock. Possibly the task was done in less time by a greater flow of water.

Here, then, we have the material of which the Colorado Desert has been built. There are more than a million acres of land in the desert, and the sediment is known to be more than 600 feet deep in one place, with no knowledge of other places.

We have little difficulty in picturing to ourselves this great constructive force of nature, bearing down and casting into the sea, where it was but seventy-five miles across, this great mass of earth. By inches, as the centuries were unfolded, we see the earth rise above the

GATHERING GRAPES IN SOUTHERN CALIFORNIA.
View of an irrigated vineyard.

Growth of Egyptian Corn on the Former Desert.

waves near the shore. We see it creep out across the water as time grows old—a narrow jetty, bearing the waters of the river upon its crest, until the land has spanned the Gulf and cut it in twain.

Then we see a succession of centuries during which the river shifted from time to time, now flowing into the Gulf and again tumbling off the northern bank of the dam into the newly-created sink. While the river water flows into the Gulf, we see that in the sink evaporate, and the site of the vanished water becomes a forbidding desert a hundred miles or more across. As the river turns to the sink, we see the waters rise again and become an inland sea of salt water, for none of the saline properties have been lost by the evaporation of the water.

Possibly a thousand or ten thousand times the inland sea has come and gone, with each renewal receiving a vast amount of sediment deposited by the river, and with each disappearance leaving the salt of the water deposited in the lowest portion of the sink.

And with all this, the dam which shut off the sea grew until it was fifty miles wide and rose forty feet above the ocean-level, making the sink as safe against the encroachments of the sea as any city built down by the tumbling waters.

Inroads of Man

Then the Indian came—the slim, gaunt, hungry Indian, the Cocopah, brother of the desert rat that lives on insects, twin of the coyote that goes fifty miles to drink and fasts for a week when necessary. He came here through fear, banished by dread of the more powerful tribes of the mountains—fearless men, but not heroic enough to hunt and slay their brothers in this desert wilderness. And thus it came that the desert was strewn with crockery and other evidences of long occupation by the aborigines.

The white man came with his stage line across the southern border, where there is a series of picturesque little lakes, and later with his railroad across the northern border. During the white man's knowledge of the country, but once—in 1891—had a considerable quantity of water found its way from the river to the basin, and then the Colorado corrected itself without human aid. But Indian traditions say it had happened several times since their race had known the land.

Reclaiming Salton Sink

About five years ago a corporation—the California Development Company—began the work of bringing in water from the Colorado river to irrigate the desert; and at about the same time the development of an artesian belt began in the Coachella valley, a section of the desert. Colonization was begun at once, and has continued rapidly. Only a temporary headgate was put in the canal leading from the river; and during the winter of 1904-05 the river was so low that sufficient water could not be ob-

On Mexican Side of International Line.

tained for irrigation with the canal heading as then constructed, and a second temporary opening into the river was made, this one being below the international line in Mexico. There came an unexpected flood of the river, and it soon had cut a channel which brought practically the entire river to the sink.

This was a serious matter for the Southern Pacific Railroad, which traversed the desert at almost its western extremity. The company was forced to move its track back to higher ground. It was anxious to head off the water as quickly as possible, and resorted to a quick but cheap expedient with this in view. An untimely rise in the river washed out the work in hand.

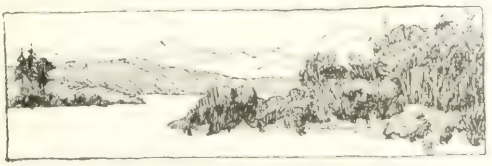
Then work was begun in a serious and substantial way, by building a permanent heading for the canal above the point where the water now comes from the river. This will be of cement and steel, and will be capable of carrying all the water of the river at low stage. The river will be turned through this, the break in the bank below closed, and the gate will then be closed at pleasure. There is every reason to believe this work will be effective in controlling the river, and that by May 1, if the water is low, the Colorado will be effectually conquered.

As for the farms, they are in no danger beyond the fact that a few hundred acres have been flooded for short times by the river flowing through the country, and this may happen again. The water in Salton Sink is about 20 feet deep at the point where the sink is 265 feet below sea level, and the lowest farm is about 100 feet below sea-level. It is estimated that it would take the Colorado river from five to eight years to raise the inland sea to the level of the lowest farm, and there is not the slightest doubt that long before that time has elapsed the river will be flowing again in its accustomed channel to the Gulf.

During the last few months there has been a revival of the old period of fiction.

Drop in One of the Smaller Canals.

The report has been sent broadcast that an earthquake has opened a passageway from the Gulf to Salton Sink. There is as much foundation for this romance as there is for the rumor that the man in the moon suffers from appendicitis—and no more. It is a romance which might have been made laughable a decade ago, but is now vicious, in that it casts an aspersion on a country where $15,000,000 of values has been created from nothing in five years by a band of dauntless pioneers.



Gun-Cotton Used as Fuel

Hiram Maxim's Revolutionary Discovery of "Motorite," an Emergency Fuel for Torpedo-Boats and Submarines

By WILLIAM R. STEWART

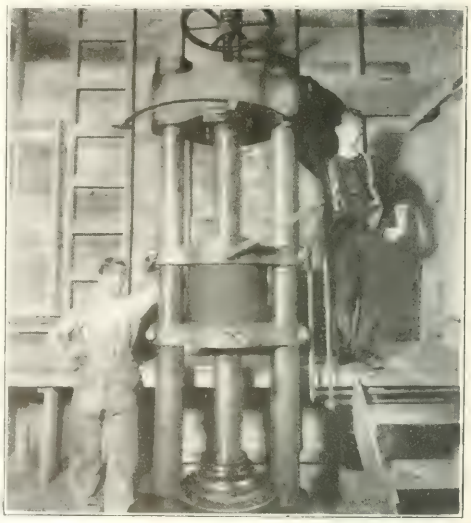
"LIGHT another hundred-foot candle of condensed gun-cotton! We must make the next mile in less than a minute!"

That command, or something like it, will be given by the commander of a United States torpedo-boat in the next war in which this country may unhappily be engaged. It will not mean that, finding his ship in a desperate situation, the captain has decided to blow himself and his whole command out of the water. It will signify only the adoption as emergency fuel of the wonderful new compound, "motorite," a secret composition of gun-cotton and nitro-glycerine, invented by Hiram Maxim, whose "Maximite" is the high explosive now used by the Government in submarine torpedoes.

"It was an idea turned backward which created 'motorite,'" said Mr. Maxim, when I saw him at his shops near Lake Hopatcong, New Jersey, where most of his experimental work is done. "While we make high explosives by inducing as nearly as possible instantaneous combustion, motorite is a compound of gun-cotton and nitro-glycerine made to burn slowly. When I say 'slowly,' I mean, of course, in a comparative sense; without the speed of an explosion, and so utilized that each pound of motorite will produce three pounds of steam. Nothing else—not even compressed air—gives so much motive power in so small a compass."

In brief, the one supreme property of motorite which gives it its most remarkable and peculiar value, is that it is capable of burning without atmospheric oxygen, producing a very hot flame. In using it as a motive power on a torpedo-boat or submarine, the method employed is to burn it in a confined space under pressure and to utilize the heat of the combustion, or the flame, to evaporate water, by directly mixing the water with the flame. By this method no boiler is required, and thus a great amount of space and much weight are saved. Mr. Maxim is also prepared to demonstrate that motorite will provide more than double the power of which compressed air is capable, for an equivalent length of time.

Motorite, when used as fuel on torpedo-boats or submarines, will be compressed into huge candles, or rods, a foot each in diameter, and solidly encased and tightly sealed in steel cylinders a hundred feet long. When it is desired to raise steam one of these candles of gun-cotton and nitro-glycerine will be ignited at the rear end; and, as the sides of the candle are protected from ignition, it will



GIANT PRESS FOR COMPRESSING MOTORITE UNDER 16,000 POUNDS TO THE SQUARE INCH.

IN THE MOTORITE PRESS HOUSE AND CHARGING ROOM.
Mr. Maxim standing beside a huge motorite tube.

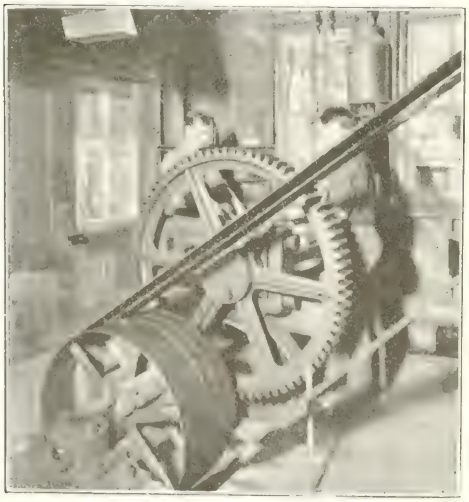
continue to burn only at one end. The heat is used directly to evaporate water, the resulting steam and the gaseous products of combustion being forced into powerful turbines, while the exhaust gases escape at the rear beneath the water; or, if desired, the smokestack may be raised and the exhaust conducted through it to the open air.

In a semi-submarine torpedo-boat about 275 feet long, 32 feet wide, and 30 feet deep, thirty cylinders 100 feet in length could be provided and filled with solid rods of motorite a foot through. The motorite contained in one of these cylinders could, under a pressure of 250 pounds to the square inch, burn for more than an hour; and the products of combustion, together with the steam generated, would supply to the turbines 23,000 pounds of mixed gases and steam an hour. At the rate of 23 pounds of steam and gases per horse-power hour, this would develop 1,000 horse-power for that time. If half the number of cylinders were ignited at once, 15,000 horse-power would be supplied for two hours. If the whole number were ignited, then there would be had 30,000 horse-power for an hour.

By increasing the pressure slightly, the rate of combustion could be doubled, even quadrupled, and 60,000 horse-power could be furnished for half an hour, or 120,000 horse-power for fifteen minutes.

BOILER ROOM, SHOWING WALL MADE OF OAK AND ONE FOOT THICK.
Behind this wall, experiments with motorite were carried on.

"Motorite" would prove expensive fuel, as it would cost, according to its discoverer, about $2 per horse-power hour, and it would, therefore, cost about $60,000 to run the boat for an hour with 30,000 horse-power. Although expensive, however, it might sink a $5,000,000 battleship—perhaps more than one. Moreover, full speed would not often be required for more than a few minutes at a time.



Rolling Motorite into Sheets.

The discharge of motorite-propelled torpedoes from torpedo-boats or battleships, Mr. Maxim says, will be controlled from the look-out tower by an electrical keyboard and table specially designed for the purpose. So rapidly might this keyboard be manipulated that the operator could discharge 5,000-dollar torpedoes with the rapidity of the operation of the keyboard of a typewriter by an experienced finger, while his observation would enable him to lengthen or shorten the range of his projectiles by witnessing where previous ones strike, so that he could use the gun itself for its own range-finder.

The construction of the Bliss-Leavitt torpedo, apart from the form of motive-power employed, will practically be followed in making the motorite-propelled weapon. This torpedo is in three sections: first, the head, containing the explosive (Maximite); then the central flask, containing the compressed air (for which motorite will be substituted) for driving the torpedo; and lastly the after-body or tail, which contains the turbine for operating the propellers, the immersion chamber for regulating the depth of the torpedo in the water, and the

gyroscope gear by which the torpedo is automatically steered and kept in position during its line of flight to the hostile vessel.

When the torpedo is launched from the ship's tube and enters the water, the revolution of the propellers releases a sleeve, which uncovers the firing pin, putting it in position to strike the detonating primer at the instant the torpedo hits its object. sure of the water at the given depth at which the torpedo is to travel. If the torpedo is to descend below that depth, the water pressure overcoming the springs pushes the diaphragm inwardly. If, on the other hand, the torpedo is above the desired depth, the springs overcome the water pressure, push the diaphragm outward, and allow more water to enter, thus sinking the boat to the re-

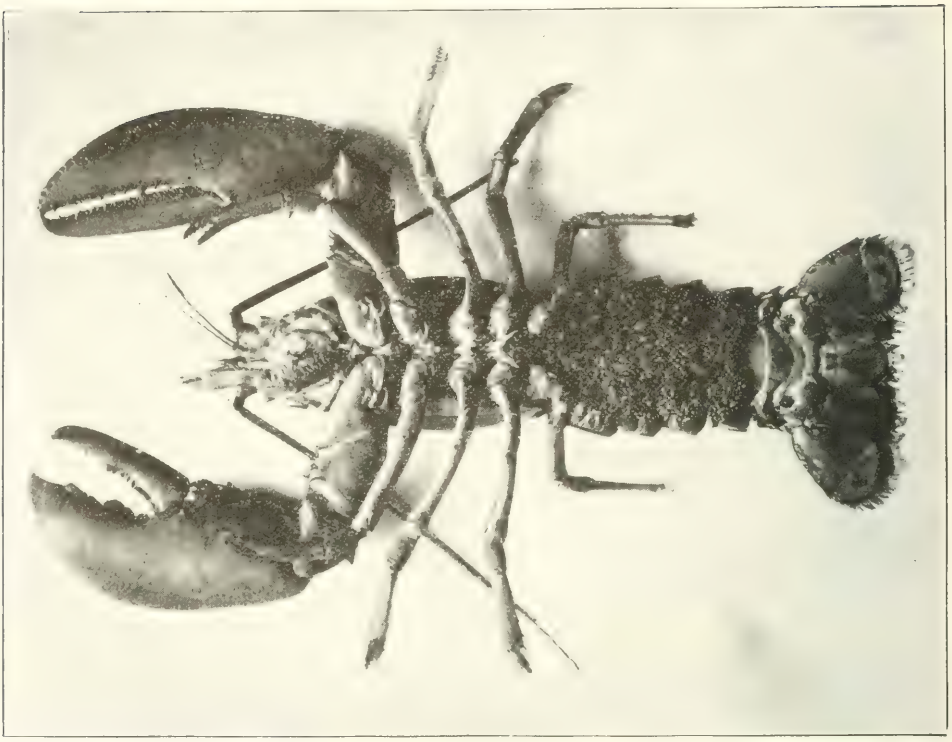
CORNER OF ROLL ROOM WHERE MOTORITE IS MADE.

The air chamber is to the turbine engine of the torpedo what the boiler is to the reciprocating engine of an ordinary steamship. The tail of the torpedo contains in its forward end a wonderful little engine which drives the whole. It consists of a central row of fixed blades and two wheels, one 11⅛ inches and the other nearly 12 inches in diameter. There are two propellers running in opposite directions.

The apparatus by which the depth of immersion of the automobile torpedo is regulated is quite wonderful. On one side are holes for the water to enter, and on the other a series of coiled springs so adjusted that the pressure is exactly equal to the pressquired depth. By previous adjustment, the torpedo can be set to run at any desired depth and keep that depth until its object has been struck, or the torpedo has expended itself.

Were it not that Mr. Maxim is the discoverer of the high explosive adopted after competitive tests by the United States Government, and also the first experimenter in this country with smokeless powder, one might perhaps doubt the probable realization of all that is predicted for motorite. As it is, and from knowledge of the man, the writer believes that the next war in which this country is engaged will see the wonders of "motorite" startlingly revealed to the world.

"BERRIED LOBSTER."
Showing how the mother carries the eggs from which her young are hatched.



Quarrelsome Cannibal of the Ocean

Homarus Americanus Lives the Life of a Greedy Robber, and Is Usually Boiled Alive at the End of It

By HENRY MORROW

THE first sensation of life came to Homarus Americanus in the shape of a strong current of water, which swept him away from the place to which he had clung for months. The next instant another current caught him and carried him to the surface of the ocean. All about, on the top of the waves, swam thousands and thousands of his brothers and sisters. When finally the last of the spawn had been swept away from its hold on the mother's legs by the fanning motion of her broad, flat tail, no less than 30,000 baby lobsters were paddling aimlessly about together. No one would have recognized them as lobsters, however. They looked like tiny worms, with short, waving legs and with big, goggle, lighthouse eyes mounted on little stalks which grew upward from the head. There was no sign of the big front claws or the broad, flexible tail.

It was in mid-May, and the sun beat down warmly. Though so small and so helpless—and though he had already bidden his mother a last good-bye—young Homarus Americanus rather enjoyed the sensation of swimming around freely in the warm salt water. He was almost one-third of an inch long and began to feel quite important.

Perils of Early Life

He had already been a whole hour out of the shell, and was wondering, as he surveyed the swarming multitude of his brothers and sisters, whether there was

room for anything but lobsters in the ocean, when, in one awful moment, his doubts on that subject were forever settled.

Up out of the depth below him, with a tremendous rush, came a monstrous creature, with a yawning, cavernous mouth. Homarus Americanus was swept helpless to one side by the rush of the water; but his wabbling goggle-eyes might have told him, if he had not been too frightened, that some eleven or twelve hundred of his brethren had disappeared into the maw of a foot-long herring.

As a matter of fact, Homarus was not particularly impressed by the catastrophe. An instant later he was swimming about again as before, with the somewhat lessened swarm of his family. The herring waited only till the scattered larvæ had come close together again; then, with open mouth, he made a second rush, and engulfed another thousand.

Most of the first three days of Homarus's life was spent in involuntarily escaping being eaten alive. At the end of that time there were not more than a thousand of the original family left. Twenty-nine thousand had forever lost the opportunity of being boiled alive by civilized ladies and gentlemen.

The Moulting Process

When, on the seventh day, Homarus felt a curious pain in his back, he began to think that he, too, was destined to join the great majority. And nobody could have been more surprised than he when his back suddenly split open, and he crawled out of his own skin, leaving behind him, as well, the lining of his stomach and intestines. Now the new, fresh surface of his body was very soft and porous, and he could plainly feel the sharp tingle of the salt water as it soaked into him. He developed, also, a tremendous appetite for the tiny diatoms that float on the surface of the sea. In a day or two, however, his outside grew harder and impervious to the water; and, then, almost at once—and this time without any great surprise—he changed his inside and outside skins once more. Four times in two weeks he moulted; and after each moult, while the new skin remained soft, he could fairly feel himself growing bigger and stronger by leaps and bounds.

All the time, too, Homarus was in constant danger of his life. Scores of times

LOBSTER REARING RAFT.

he narrowly escaped being engulfed in the ravenous jaws of some surface-swimming fish. In a large degree he owed his safety to sheer luck, though it may be that his extra size and strength helped to some slight degree. After the fourth

Lobster Eggs and Larvæ (Natural Size).

moult, Homarus grew very rapidly, but he did not change his skin again until a whole month had gone by. Then he had begun to grow tiny front claws, and to feel quite like a lobster in miniature. After he had crawled out of his skin for the fourth time, he found no further pleasure in swimming about on the surface of the waves. Instead, he dived down to the sandy bottom, and scuttled in shore to where the water was shallow and he could find a place to hide.

Migrates to Bottom of Sea

Presently he came to a spot where a narrow opening led in between two good-sized rocks. He started boldly through that opening, but backed out again with astonishing swiftness, for just within lay a terrible monster, with enormous claws and awful goggle-eyes. The mandibles of one of those great claws clicked together, just grazing his tail as he shot backwards and hastened to burrow in the sand outside. Fortunately he did not know how nearly he had come to furnishing a light luncheon to his own mother; and she, if she knew, did not at all care.

Still changing his skin every few weeks, Homarus continued to grow larger, bolder, and more voracious. He presently found a den of his own under a flat rock, and there he lay in wait for whatever living thing might come within striking distance. His big eyes, mounted at the top of flexible stalks, could be pointed in any direction, so that he could survey the whole floor of the sea nearby his hiding place. But his eyesight was not good, and he depended almost altogether on the long sensitive antennæ or feelers which grew out from his head, and which responded to the slightest movement in the water.

Comes to Maturity

When Homarus was a year old, he had already moulted seventeen times, and measured all of three inches in length. He had multiplied his original length by nine in twelve months. Also, he was now a real lobster, fond of fighting and feasting, and possessed of no virtue which anyone could detect—unless the incomparable flavor which betrays so many of his kindred to the salad bowl be counted as such.

At this time, if a census of the immediate family of Homarus Americanus had been taken, it would have shown that out of 30,000 original children, only ten were left. A total of 29,990 had miserably

Lobster after Fourth Moult.

perished in their infancy. And yet the scientists of the Government Fish Commission have estimated that if two out of every 10,000 lobsters survive and grow to adult age, the species will be maintained at its normal number.

One day Homarus caught the delicious smell of a dead fish, and crept quickly out of his den to go in search of it. Those who have seen a lobster writhing almost helpless on the ground would have

been astonished to see how swiftly and gracefully he hurried over the smooth sandy floor of the ocean, touching only the tips of his long, slender legs.

He was nearing the piece of carrion, when suddenly, out of the deep-sea gloom, another shape appeared. It was that of a second lobster, fully an inch longer than the yearling Homarus. But the smell was too tantalizing, and his appetite too keen, to allow him to run away without making at least an effort to seize the prize. The bigger lobster barred his path, with big front claws upraised, ready for battle. Homarus truculently advanced, and in an instant the two were locked in a struggle which lasted only a moment, at the end of which poor Homarus found himself with one of his front claw-bearing legs torn entirely away from his body.

The injury would have been fatal to a child or to one of the higher animals, but Homarus felt only a temporary and not particularly severe pain. He did, however, scuttle back as rapidly as possible to his den, and there remained closely in hiding until his next moulting. By that time a brand new leg and claw had grown out, the new member being a little larger and stronger than that which had been lost.

Every three weeks, Homarus now cast his skin; and after each moult he grew very quickly an inch or two longer, and correspondingly wider and heavier.

Scuttles into Deep Water in Winter

When winter shut down on the land outside, Homarus also felt the chill moving slowly, creeping through the shallow water where he lived. So one day he left his old home, and went on a house-hunting expedition out into the sea where the water was 300 feet or more in depth. Down there it was colder in summertime than near shore; but in the winter it was warmer, the surface cold not penetrating to that depth.

It was on this journey that Homarus met with a new and startling adventure. He was skipping along at a good pace on the ends of his toes, when suddenly, from behind a screen of seaweed and coral, a great, flat skate, with tremendous open mouth, made a sudden dart at him. With a quick, convulsive flexion of his broad, flat tail, Homarus threw himself backward through the water, darting a distance of twenty feet with a single motion, and in less than a second. The clumsy skate made no effort to pursue, and Homarus hurried on seeking some nook or cranny in the rocks where he might hide.

Presently he found a sort of cave, beneath the roots of a waving seaweed, and there he lay hidden, with only the projecting antennæ to warn him of approaching food or foe. Of a sudden the sensitive antennæ telegraphed to his brain

Emptying a Lobster Pot.

that something was coming. Out poked a goggle-eye, on the end of its stalk, to see whether the oncomer was good to eat. It was a lobster, smaller and less formidable than Homarus himself. Then the cannibal thrust one of his big claws to the very entrance of his den, and, waiting until the unsuspecting one was exactly opposite, suddenly seized its body firmly between the sharply-toothed mandibles. There was an instant's struggle; but it happened that the victim had but newly moulted, and its fresh skin was soft. Homarus crushed it to death without difficulty, then dragged the dismembered body inside his den, and devoured it at his leisure. The fact that he was eating his own sister affected his appetite not at all.

The regular casting of his skin had now become a more serious matter with Homarus. For several days beforehand, he twisted and rolled and squirmed within his tightly fitting suit of armor. He was loosening his shield, and exercising his muscles in preparation for the coming ordeal. Finally he bent himself

PACKING LIVE LOBSTERS.

After being sorted according to sizes, the lobsters are packed in ice and shipped to market.

into the form of a letter V, and remained in that position, rigid, with all his muscles pulled taut. At last a gap appeared between the carapace, or armored covering of his back, and the overlapping plates of his tail. The skin inside the armor-plate broke also, and then the armored back-covering rose, forced upward by the flexed position of the body. Then Homarus literally backed out of the front part of his shell, leaving it behind him entirely whole and uncracked. His soft claws were much distorted by being pulled through the narrow exits from their discarded sheaths. Inside the old shell, Homarus left, also, all the linings of his stomach and intestines. With half a dozen vigorous lashes the old plates were shaken from his tail, and he lay panting in his new, brilliantly green covering. But he was soft and tender, a tempting morsel for even a soft-mouthed fish. Instinctively he realized how defenseless he was, and he hastened to hide himself in the very depths of his den. Within the next six or eight weeks, while his new skin remained soft, he grew an inch and a-half in length. Then, as his armor hardened, he stopped growing altogether.

During this long period, the sense of danger had kept Homarus close at home, and food had been hard to get. Now, feeling himself again comparatively safe, he ventured out one night, attracted by the strong and appetizing smell of decayed fish. He ran rapidly along the ocean floor, coming constantly closer and closer to the source of the tantalizing odor. Now it was right before him, but a hard substance barred his way, and kept him from grasping the treasure with his claws. All about the rectangular structure he prowled, looking vainly for an entrance. Finally, at one end, he found a soft, yielding passageway, through which, with some difficulty, he forced his way. There, before him, lay a great chunk of delicious tainted fish. For several minutes he gorged, then suddenly stopped short, stricken with an awful fear. With a dart he tried to leave the vicinity of the danger, but wooden bars stopped him. For an hour he rushed frantically from one side to the other of the trap. Nowhere was there a chance to escape. So, at last, he settled down sullenly in one corner to await what might happen. During the night, at intervals, other lobsters came into the trap;

and when Homarus felt a sudden pull lifting him up from the bottom, there were six lobsters inside the trap. Up they went, till finally a heavily mittened hand reached over the side of a row-boat, and lifted the trap into the air, resting it on the gunwale. Then the door was opened, and the mittened hand seized Homarus about the body. He struggled desperately and tried to pinch the hand in his claws; but its owner only laughed and said, speaking to himself, "D—n sassy for a little cuss, but I ain't taking no chances on anything less than ten and a-half inches long this year. The fish warden ain't goin' to get me, by Silas!"

With a careless toss he threw Homarus back into the water, and went on lifting out the larger lobsters, which he put one after the other into the deep bottom of his dory.

One would have thought that would have been a lesson to Homarus. But within a year he had forgotten it, and, now well over the ten and a-half inches in length, he found himself again in a lobster trap, a victim to his own greed for carrion.

This time when the trap was pulled up, there were two people in the dory. One of them was a bronzed old fisherman, the other a young boy, his son. The boy excitedly opened the door of the lobster trap, and seized Homarus by one of his huge front claws. Homarus waited until he was well out of the trap, then instantly detached his body from the claw and fell back into the ocean, leaving the boy gaping at the claw which he still held tightly clutched in his hand.

As Homarus fell, the old fisherman burst into a roar of laughter.

"Too smart for you, by Ding!" he shouted in derision at his son. "Don't you know yet that a lobster kin cast his claws? Where was ye brought up, anyhow?"

A Victim of His Own Voracity

For the third time, a few months later, stupid Homarus forced his way into a trap. And good fortune had at last deserted him. He was carried in the dory to the shore, where he was confined, with hundreds of his kindred, in a big floating car, until one day a lobster smack came sailing in, and, in exchange

CRATE OF LOBSTERS ON THE WAY TO THE BOILERS.

for certain pieces of silver, Homarus and his brothers were transferred to its owner, who threw them into a deep well in the hull of his ship, where, altogether, 5,000 lobsters were waiting their doom. When the smack reached the dock, her catch was sorted according to size, all those of each size being put into another floating car, moored near the shore.

After enjoying for some twenty-four hours his last taste of sea water, Homarus was dipped up out of the car by a man with a big ladle, and carried away to a long, low building close to the docks. There Homarus was put into a crate with iron bars, which was already overfilled with his kindred. But just at the last moment, Homarus and one or two others were taken out, so that the lid could be shut down. Fortunately Homarus lacked the wit to watch as the crate out of which he had happily escaped was lifted up by a rope and then lowered into a huge tank of boiling water. There the crateful of lobsters was slowly boiled alive, the process taking forty minutes before their dark green armor had entirely changed to a vivid red.

Presently Homarus was picked up by the body, and a strong rubber band was slipped over each of his big claws so that he could not attack his equally quarrelsome fellows. Then he was thrown into a barrel, in the center of which stood a tall column of ice, and on top of him were piled other helpless lobsters, until the barrel was nearly full. It was packed with crushed ice and seaweed, and over all was fastened a piece of bagging.

The fast express carried Homarus 1,000 miles inland; and the other night Mrs. Jones of Chicago, who had just finished crying over her little boy's cut finger, dropped him into a pot of boiling water, and was really quite amused by his frantic, but utterly hopeless struggles.

Somehow, in spite of the fact that he was a cold-blooded crustacean, Homarus Americanus did not seem to enjoy it. But he made a delicious salad.

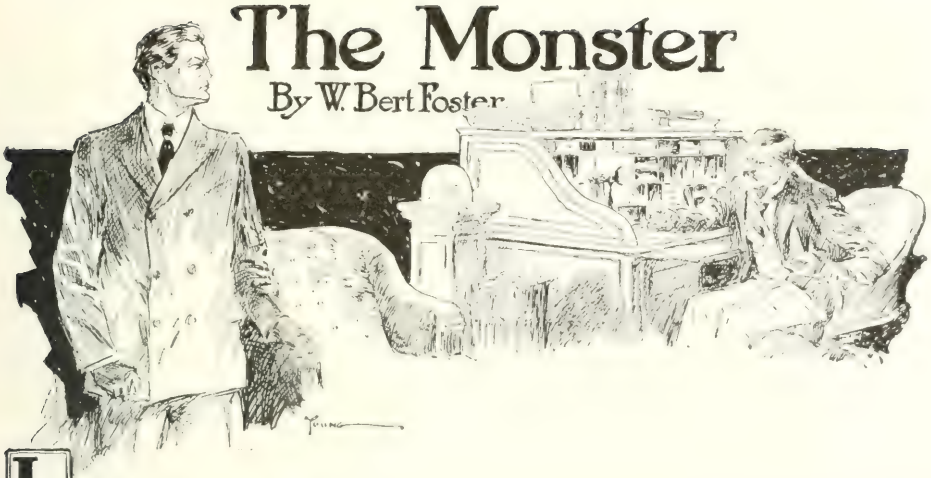
What Have You Done To-day?

WE shall do much in the years to come;
But what have we done to-day?
We shall give our gold in a princely sum;
But what did we give to-day?
We shall lift the heart and dry the tear,
We shall plant a hope in the place of fear,
We shall speak the words of love and cheer;
But what did we speak to-day?

We shall be so kind in the after-while;
But what have we been to-day?
We shall bring to each lonely life a smile;
But what have we brought to-day?
We shall give to truth a grander birth,
We shall feed the hungry souls of earth;
But, this is the thing our hearts must ask:
What have we done to-day?

The Monster

By W. Bert Foster



LORRETTO'S chubby fist descended upon his desk with an angry thump; the little man was crimson of face, and his black eyes snapped. "The boys" who came in personal contact with the president of the O. & D. B. Railroad were rather fond of him; but when he got mad and roasted them, they called him "the Dago." He had the quick temper of the Latin as well as the far business sight of his Saxon ancestors. The temper was almost out of control now.

"I'm disappointed in you—my own sister's son!" he snapped, eyeing Hadley malevolently. "You're a failure—an utter failure. What do you mean by it?"

Hadley uncoiled his lazy length from the armchair, and stood up. His own blue eyes began to take fire.

"You're not complimentary, Uncle Joe," he said. "I don't fancy being called a failure! You give me something to do that any man of my muscle and brains *can* do, and I guarantee you your money's worth. But don't blame me for the interposition of Nature. Circumstances—"

"'Circumstances!' What *are* circumstances?" repeated Lorretto, angrily. "They're things to be trampled under foot—that's what they are. The Mountain Division would never have been built in the first place if I had been balked by circumstances."

"Too bad you wasn't balked. You've got two hundred miles of track that comes pretty nigh being worthless to the system from October first to the last of April," returned Hadley sharply. "Now, Uncle Joe, you'd better let me go, till we both cool down. I know what I've been through this winter, and you don't. A hundred miles of snowsheds wouldn't keep that line open—I swear it wouldn't! What sheds we had were most of them crushed flat by avalanches. I admit the grade isn't bad; we make good time in pleasant weather. But when the snow begins to fall—well, we might as well send our engines back into the roundhouses and lay low till the snow melts again—I mean it! You don't know what I've been through. 'Plows!' Don't talk to me of plows. Wasn't I out myself for four days at Antler Pass with a gang, trying to clear the road. I didn't have my clothes off all that time; when we got through, they had to cut my boots off my feet, and I reckon if I'd put those same feet in a tub of water, it would have boiled!

"I've been frost-bitten from head to toe; I've shoveled snow till my joints cracked every time I moved; I've kept other men to work at the point of a gun; and then, after clearing a cut, seen an avalanche fall and fill it up again higher than it was before! You've cut down my allowance of men, and cut off my expense account, and then you call me a failure!

"'Plows!'—ugh! Don't talk to me. There isn't a 'snow-hog' on the road that's worth a tinker's damn. What's

the good of butting into the drifts a machine that merely pushes the snow aside? Bah! that's nonsense! We don't want plows on the Mountain Division; we want something *to eat the snow up.* W've got to get rid of it, not push it aside."

He stopped suddenly in this harangue and sat down again. Lorretto looked at him with a puzzled frown, waiting for him to complete his speech; but Hadley seemed to have fallen into a brown study. His gaze was fixed, and his lips formed unuttered and broken phrases.

"Well, what's the matter now?" finally asked the president, still gazing at the young superintendent of the Mountain Division in perplexity. "Gone to sleep, eh?"

Hadley sighed, and slowly came back to material things. His brow corrugated with a frown; he looked again at his uncle.

"Look here!" he said, "I'm a failure, am I? And the division's a failure? Will you give me another year—and twenty thousand dollars extra, over and above my budget?"

"What! what! Good money after bad?"

"As a speculation," said Hadley.

"It's a speculation in discounted securities," gibed Lorretto. "No!"

Hadley's eyes flashed again. *He* smote the desk this time. "I've got twenty thousand of my own. You sha'n't call me a failure yet," he said, determinedly. "I'll use my own money in this attempt, if you'll give me another year."

"I'll give you the time—yes. What's your scheme?"

"None of your business," returned his nephew, flatly. "If I'm to risk my own money, I'll not be interfered with. You say the Mountain Division is of great importance to the system; I'll keep it open next winter if such a thing be possible. There's my hand on it!"

"Oh, I'll shake hands with you," grunted Lorretto. "But I've mighty little confidence in your wild-goose schemes. So! I must satisfy the directors, too, I suppose? Well, that comes of taking my nephew into the business."

"I wish you weren't my uncle," returned Hadley, calmly, "and you were about two feet taller. I'd take you outside and beat you to a frazzle for *that.*"

* * * * * *

When a man is twenty-six years old, and is called a failure, it makes him mad; at thirty-six it makes him sad; ten years later he knows it isn't so, for if he hasn't gained enough philosophy by *that* time to "take things as they come," he hasn't brains enough left to appreciate his position, anyway!

Campe Hadley, being twenty-six, was angry. Otherwise he would not have risked his own little fortune in such a "heads I lose, tails you win" game. He had had the winter's experience with his mountain branch of the O. & D. B., and he knew what he was "up against." The winding road was built on a moderate grade; and during the summer there was plenty of traffic on the line; but as Lorretto declared, the Mountain Division had been nothing but an expense to the O. & D. B. during the winter months.

Snow began to fill the cuts and heap over the short levels with the first downfall; and from that time until the spring freshets washed out the passes, it was a losing fight for the division. One train had been marooned in Antler Pass for the better part of a week; trains were one, two, and three days late; the schedule had been, in the words of Wayborn, the old train-dispatcher, "busted to flinders!"

And with the knowledge of all this behind him, Campe Hadley was ready to risk his fortune and another twelve months' labor in an attempt to make the Mountain Division at least a non-losing, if not a dividend-paying, institution!

He left a deal of the management of the branch to old Wayborn; you could find Hadley himself most of the time at Baldcap, where the new shops had been built. President Lorretto paid little attention to his nephew and the Mountain Division after that final interview in his office at headquarters; to himself he admitted that, had Hadley not been his sister's child, he would have satisfied the directorate of the system by letting him go at once. The deficit reported from the division for that winter was enormous.

Occasionally whispers of something his nephew was about at Baldcap reached

the little president's ears; but he closed them to gossip. Meanwhile, during the "open" season, the Mountain Division was proving its value to the O. & D. B. There wasn't a dozen passenger trains a day over the route; but despite the grade, the freight traffic was phenomenal. All the ore from the Antler and Six Brothers mines, as well as a dozen smaller claims, fell into the hands of Hadley; and many thousand feet of lumber came down the line, too. If the roadbed could only be kept open during the winter months, the Mountain Division would be one of the best paying branches of the O. & D. B.

This fact, and the additional truth that the building of the branch had been a pet project of Lorretto's, and that he hoped some day to see it completed through the Wind River Mountains to a junction with the northern and western trunk lines, had urged the president to "stand off" the board of directors and give his nephew another year at the problem. Faint as his hope was that Hadley could "make good," Lorretto closed his eyes and ears to what really appeared to be utterly unconquerable obstacles in the young superintendent's path.

Somebody told him that Hadley's scheme for the coming battle with the snows included a new-fangled plow, and that it was on such an invention his nephew's time and money were being spent; but he would not ask Hadley to report. Apparently he had no interest in what was going on in the Baldcap shops; even in the late fall, while on his yearly tour of inspection, which included the Mountain Division to the end of the line, deep in the heart of the hills, he asked no questions as to what the superintendent proposed to do when the Storm King seized the line in its grasp.

In truth, he did not see much of his nephew on this trip. Lorretto went up with a party of the directors and friends in his private car, and they remained a week at Last Jump for a bear hunt. Hadley met them at the junction, rode as far as Baldcap with them, and then sent on his assistant to play host for the rest of the way. The party could inspect the Baldcap shops on their return.

The lack of game was really what delayed the party; never before had bears been so scarce at this time of year in the hills; and the hunters would not believe one old guide who declared that the creatures had already taken to their lairs so early in the season. The morning, however, that they awoke to see the sun glittering on the snowy coverlet of nearby peaks, the approach of winter was recognized by all hands. Lorretto urged an immediate return to the plains.

They were encamped some miles from the railroad, however, and it was mid-afternoon before they reached Last Jump. The sun had disappeared then, and there was no engine at hand to draw the special south. Before this was remedied, the flakes began to fall, and the special finally started out with an ordinary brush plow in front to sweep the light snow from the tracks.

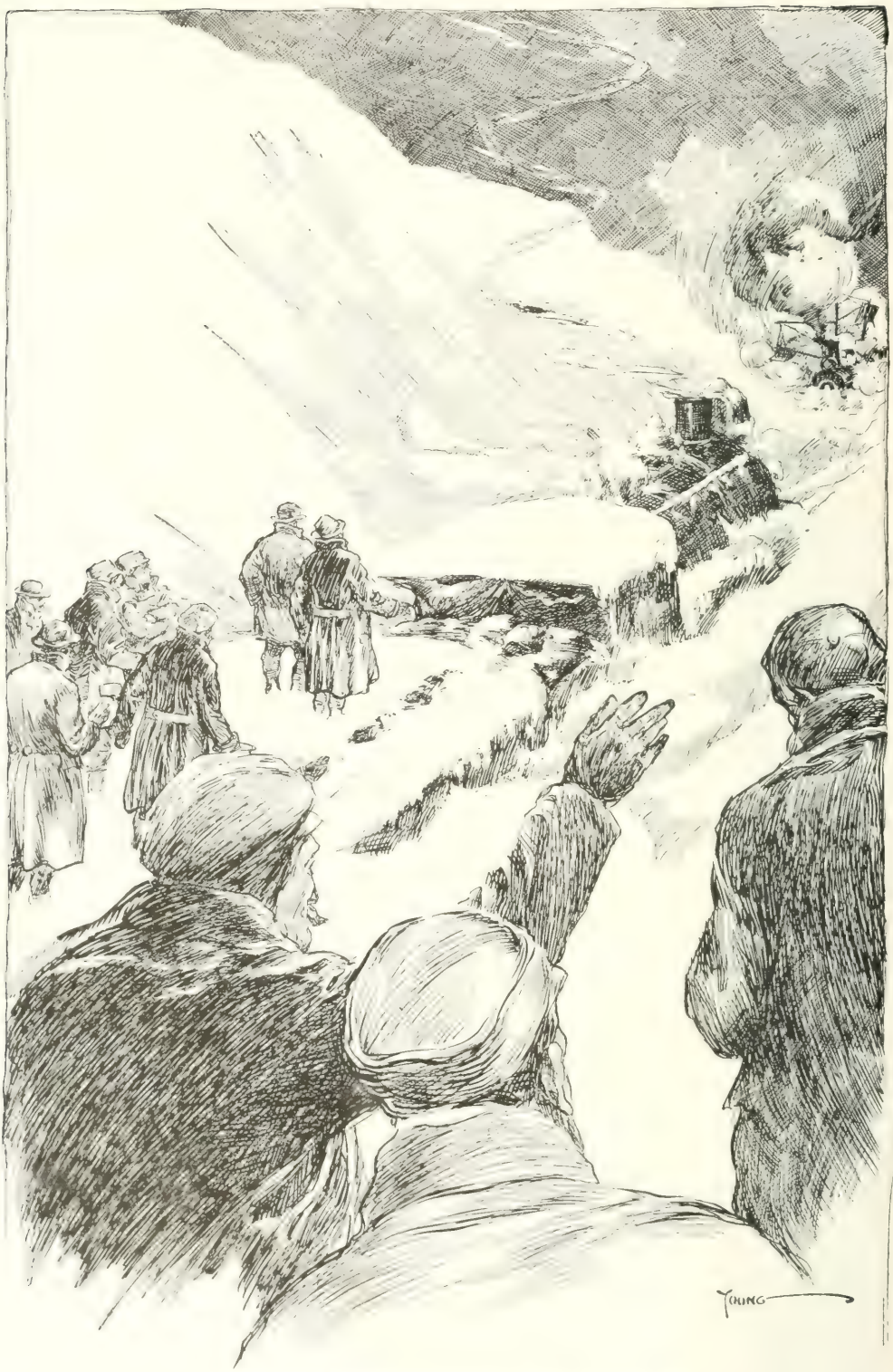
Twenty miles down the line, the brush was switched off, for one of the heavy "snow-hogs" was banking the snow up on the right hand, and it was wired that the full complement of plows and men were at work all along the line. Unless one has experienced such a storm in the mountains, the rapidity with which snow gathers may not be easily understood. It began to drift, too.

All might have gone well had not an ore-train broken down between the special and the "snow-hog." Up to this point (which was near Antler Pass) the way had been pretty clear. But in switching across the main track the freight became stalled and the president's train was held up for half an hour.

Half an hour in such a storm—the snow did not fall in flakes, but in *sheets*, which lapped the train about and were tucked in by the gale—was disastrous. The engine of the special had to be dug out before she could start again, when the wrecking gang had cleared the track.

Two misfortunes added to the unpleasantness of the accident. Night had already fallen; and telegraph communication, for some reason, was broken between the flag-station at which they were stalled and Baldcap.

"Push on!" commanded Lorretto. "We can't stay up here in this God-forsaken part of the world; the way things were run here last winter, we may be stalled till spring if we don't push through while there's some chance of seeing the other end of the pass."



"THE SNOW SEEMED TO FAIRLY MELT BEFORE IT."

And so, against the advice of the driver and other train hands, the special started once more. They had lost the plow, and the passage that useful implement had made for them was merely a ditch in the snow. The headlight of the forward engine (a second locomotive had butted on behind) scarcely revealed the way five yards in advance of the pilot. They were charging a wall of snow, and it was difficult to distinguish between the drifts which had fallen and the swirling cloud of white still in the air.

Back in the private car the visitors were taking the matter philosophically. All but the excitable little president. He well knew what the slow progress, the sudden stoppages and backings, the desperate charges into the embanked snow, meant. His cook and steward were busy supplying the train hands with hot coffee and sandwiches. Two men had been brought into the car ahead, badly frozen. To butt through the pass seemed now impossible, and to force the train back to the last station was quite as uncertain a matter.

The train finally halted for some minutes, and the conductor reported in person.

"Stalled!" was the verdict. The fuel was getting low; the snow balled the machinery; the drifts were as high as the sandbox; and the men were dead beat!

"Fortunately it's the first blizzard of the season, and there'll be a rise of temperature to follow," said Lorretto, savagely. "Otherwise we might be here for a month, as far as my precious nephew has the ability to dig us out."

He actually felt anger against poor Hadley for this storm—as though the superintendent of the division was at fault. It wasn't a particularly cheerful party who went to bed in the private coach that night. By morning the fuel was so low in the forward tender that the men were sacking coal on their backs from the tender of the rear locomotive to keep the fire under the boiler and heat in the cars.

Lorretto ventured into the vestibule between the cars, and found that the snow had utterly buried the train. He pushed on between the rows of snoring train hands, to the front platform. That had been kept clear, and he looked up to see—the snow still falling!

A shift of four men kept the engine cab open, and passed coal over the car roofs. The engineer managed to keep his coils hot and the water boiling; but the snow, melting about the rods and bearings, had congealed again into ice and not a wheel could be turned. The conductor, however, prophesied a sudden end to the storm.

But the sun did not show its face until noon. When the president and his party climbed to the roof of the forward car, they were in a world of white. The steep sides of the pass were completely hidden by the snowbanks. The smokestack of the forward locomotive sent up a spiral of blue haze; not a single other moving thing appeared. It was appalling.

"We've a good larder, and the engineer assures me we've fuel enough to heat the cars for twenty-four hours," explained the president of the O. & D. B. "There'll be a change by that time—"

"What's that?" interrupted one of his friends, holding up a hand for silence.

Borne faintly to their ears was a distant murmur—a sound which shivered in the air about them and made it difficult to decide from which direction it came, whether up or down the pass. Lorretto cast an anxious glance upward at the white walls. Was it a descending avalanche? Luckily his companions were not apprehensive on this score.

Steadily the sound increased in volume, and at last even Lorretto was assured that his first fear was unfounded. It was not the roar of an avalanche. Suddenly a sharper sound smote their ears, and they gazed upon each other in amazement. It was the distant, but clearly echoing, whistle of a locomotive!

"An engine coming up the pass!" declared one.

In that direction there was a wall of snow over which they could not even see. Surely the pass must be filled with the drifts clear to its lower end!

Nearer and nearer came the sound, as it might have been the panting of some antediluvian monster.

"Gentlemen, I don't know what it means," admitted the president; "but there is evidently some sort of a plow coming through Antler Pass—and it is coming at a surprising rate of speed."

And yet it seemed arrant nonsense to

expect a "snow-hog" to push aside the mass of snow that was heaped between the walls of the great cut. Where could it be *pushed* to? This snow must be dug out and carted away in dumps to make way for the running of trains—that stood to reason.

Yet on the monster came, panting and blowing like a living thing. The eager officials, joined by the train hands, ventured ahead of the stalled engine and mounted to the summit of the hard-packed drift. From that eminence they obtained a view of a straight half-mile of the pass.

There was a sharp curve at the end of that straight stretch; somewhere behind that curve the panting, snorting monster was at work. Lorretto saw the train hands whispering together and looking at him, but he disdained questioning them. Plainly this was not entirely a mystery to them. Had Hadley accomplished the impossible, after all? Was *this* what he had been at work on for the better part of six months?

Then somebody shouted. The pass at the curve was suddenly filled with a cloud of snow which rose like smoke into the air. For a moment the president feared an avalanche again.

But this disturbance of the snow was not from above. A tall stack appeared through the cloud, from which there floated black, oily smoke, while for yards ahead of it the heaped up drifts seemed in motion.

The black forefront of the strangest machine that had ever been seen on that, or any other, railroad, loomed into view. The snow seemed fairly to melt before it. With the panting of steam and clank of metal against metal, was now joined the swish of currents of water, and steam rose behind the smoke and snow dust as though from a boiling caldron.

The snow disappeared as if by magic as the Thing approached. The black rocks which guarded the pass just there at the curve appeared, wet and smoking; and with marveling eyes the little group of stranded railroad men beheld The Monster in its entirety as it rounded the turn.

Fancy a boiler nearly twice as long as that of the ordinary camel-back, and with a boxed-in cab at the rear, as well as the double-sectioned cab on the middle of the boiler. Forward of this "saddle" cab were two short-armed bucket-shovels which scooped half a horse-load each of snow and dumped it into a hatch on the top of the boiler, each minute. Later Lorretto learned that this snow fell upon rows of pipes through which a current of boiling water passed, was melted, and poured out below, and through vents between the huge wheels, in jets of hot water and steam, thus melting and carrying off the lower layer of snow for three or four feet upon either side of the rails.

The rails of the Mountain Division of the O. & D. B. were laid almost entirely upon a rock foundation, and the spent water and melted snow washed down the grade in the ditches on either hand without endangering the solidity of the road-bed itself.

Marveling at the clanking snow-scoops with their clock-like action, and the steady advance of the plow, the president and his companions watched in silence. Soon Lorretto descried a figure on the roof of the rear cab of the Monster, directing the men governing the machinery. It was Campe Hadley who, when his invention approached within a few rods, waved them commandingly from the summit of the drift, whence the spectators retreated to the car roof, out of danger.

In a few minutes the front of the Monster burst through the tall drift; there was a whirring of machinery, a final swish of the boiling water, and then—the drift melted and the plow stopped within a yard of the engine pilot. They saw now that the motive power of the huge machine was one of the big freight moguls built especially for mountain climbing.

Hadley ran along the running board, leaped upon the pilot of the stalled engine, and came over to his uncle and the astonished directors.

"The boys are going to couple onto your train and snake her back to the switch and siding at the lower end of the pass," he observed, shaking hands nonchalantly. "If your drawhead holds, we'll clear you out of the way and get on to finish our job before night. If I'd looked for such a snow as this when it began

yesterday, we'd have kept the pass clear all night and you wouldn't have been stalled."

Then he winked at his uncle. "What do you think of her, eh?" he asked. "She isn't handsome, and she's cost a pretty penny; but with another like her I'll agree to keep the division open and the trains running pretty near on schedule this winter. I think in time I could propel her with her own power, too—we're using solidified petroleum for fuel, you know, and that takes little room and makes a Hades of a fire."

Lorretto shook hands with him again. "So that thing cost us twenty thousand dollars, did it?" he murmured. "Well, It's worth it."

His nephew smiled grimly. "No, it cost *me* that," he said. "It's going to cost the O. & D. B. considerable more. You remember, uncle, that you wouldn't back my idea, and I must have some return for the risk I ran."

Quatorzain

MOST men know love but as a part of life;
They hide it in some corner of the breast,
Even from themselves; and only when they rest
In the brief pauses of that daily strife
Wherewith the world might else be not so rife,
They draw it forth (as one draws forth a toy
To soothe some ardent, kiss-exacting boy),
And hold it up to sister, child, or wife.
Ah me! why may not love and life be one?
Why walk we thus alone, when by our side,
Love, like a visible god, might be our guide?
How would the marts grow noble! and the street,
Worn like a dungeon-floor by weary feet,
Seem then a golden courtway of the sun!

— HENRY TIMROD.

Trolley Line Hanging in Air

Contemplated Suspended Railway for the German Capital

By DR. ALFRED GRADENWITZ

Berlin Correspondent "The Technical World Magazine"

THE problem of providing for the requirements of the rapidly growing street traffic has recently come to the fore in many European capitals; and even in Berlin, which has long been so highly praised for the excellent means of conveyance it enjoys, the inadequacy of the present tramway and railway system is keenly felt. New projects have therefore been suggested; and one of the proposals most interesting and most likely to be adopted is to install a high-speed railway on the monorail suspended system.

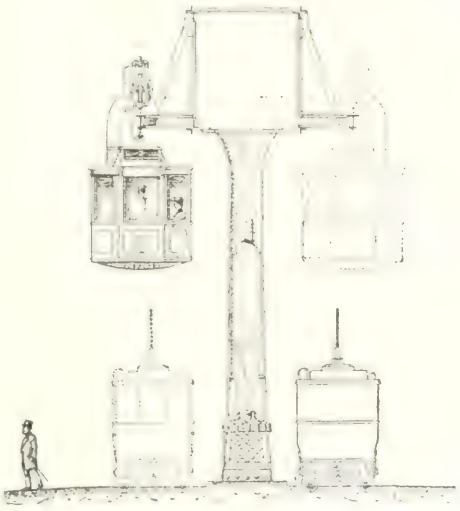
While the number of inhabitants of Greater Berlin has increased by 2½ times during the last thirty years, the passenger traffic on its tramways, omnibus lines, and metropolitan railways has increased by 20 times. It is not unlikely that the total passenger traffic will have been doubled as against the present figures, after another ten years. Now, as the tramway traffic has practically reached its permissible maximum in certain streets, while the output of the present metropolitan railways, also, is not susceptible of any further material in-

SUSPENDED MONORAIL CAR ON LINE OF ELBERFELD-BARMEN RAILWAY.
This line is proposed model for Berlin scheme.

ARRANGEMENT OF RIVER TRACKS ON ELBERFELD BARMEN RAILWAY.
Same method proposed for portions of Berlin road.

crease, the only possibility of coping with these conditions is to provide for new high-speed railways of great capacity, special care being taken to avoid as far as possible any further crowding of the already congested streets. The most congested district is obviously that part of the town which is to an ever-increasing extent becoming a center of business, while being less and less used for dwelling purposes. The new high-speed railways will accordingly have to distribute traffic over a larger area; and this result can be reached in the simplest way by installing a *north-south* railway line to counteract the present mainly western-eastern course of traffic.

The railway system suggested by the Continental Company for Electrical Undertakings is the monorail suspended railway system which has been in successful operation for some time between Elberfeld and Barmen. A special advantage of this system is its elegance in aspect, the girders being placed at about twice the height of ordinary elevated railways, while being of hardly more than half their breadth and of more open construction so as to take up much less of the air and light of the street. Its ease of dealing with curves (curvatures



CROSS-SECTION OF SUSPENDED RAILROAD.

TYPICAL STATION ON ELBERFELD-BARMEN SUSPENDED RAILWAY.

of 160-foot radius being traveled through at the same speed as those of 650-foot radius in the case of the ordinary type of elevated railway) gives this system still another advantage. The necessity of the purchase of ground is furthermore greatly reduced as compared with elevated railways. While a perfectly noiseless operation is impossible, the noise produced by suspended railways is much slighter than that of either elevated or surface railways.

The projected suspended line, starting from Gesundbrunnen Station on the metropolitan railway, would traverse Berlin southward as far as Brietzer Grenze (Rixdorf), where the other terminal station would be installed. As both terminals would be arranged in the shape of reversing loops, the two tracks of the railway would constitute a closed, uninterrupted cycle, including no switches (so far as passenger traffic is concerned); a total of seventeen stations has been provided. The length of the line, exclusive of the reversing loops and intermediate stations, will be 11.9 kilometers (7.4 miles); the maximum gradient is to be 1:30. The upper level of the rails will range from 32.8 to 70.5 feet above the level of the street. The latter figure is necessitated by the fact that the suspended railway will have to pass at an oblique angle above the western line of the metropolitan railway, where space for an additional story to that railway is to be allowed for. The same crossing results in the necessity of the high gradient of 1:30. Among other important constructions on the open track, there will be the bridging of the river Spree, where the stream will be traversed by a single span consisting of parabolical girders. Blocks of houses have to be pierced at two places. The stations are to accommodate trains made up of three cars, means, however, being provided to allow of a further extension.

At the terminal stations, all tracks are arranged in such a way as to call for only forward running of the cars. The double track terminates in a reversing loop, whence two secondary tracks are branched off, to allow of any manipula-

tion of cars that may be necessary without interfering with the service. The shed tracks connected to the reversing loop are intended for the installing of reserve cars to alter the length of the trains. The type of switch used, will follow very closely the model of the Barmen-Elberfeld line.

To support the runway, there are to be used exclusively what are called *central supports* or else *forked supports*, both of which types readily lend themselves to a rich ornamentation. As on the other hand the streets to be traversed by the railway are all very straight and slightly over 62 feet in breadth, the general aspect of this suspended railway should seem to be rather less objectionable than that of any other type of overhead high-speed railway.

The same type of car, accommodating 85 passengers, with 46 seats, is to be used throughout. Each car is provided with a special controlling device enabling it to run either singly or in connection with other cars, irrespective of the order of the latter, composite trains being controlled by the driver of the head car. To insure safety of operation, the electrically operated "Atalis" automatic block signal is to be used, which has given every satisfaction on the Barmen-Elberfeld suspended railway. A special advantage of this type of block signal, apart from its reliability, is that in case of mistakes, all there can be occasioned is a delay of trains, but never a mistake in the signals, interfering with the safety of the trains. To allow of communication between the station-guards and train-drivers, telephone plants will be provided.

Only one class of cars, with separate compartments for "smoking" and "non-smoking," is to be provided at the beginning; and the service will be started with single-car trains, running at 5-minute intervals, except during the early morning and late evening hours, for which a ten minutes' service is contemplated. A reduction to a two minutes' service will however be effected in case of necessity.

With a maximum speed of a little over 31 miles and an average speed of slightly over 18½ miles per hour, the total distance from Gesundbrunnen to Rixdorf will be traversed in 22¼ minutes.

In the case of a two minutes' service with three-car trains, it will be possible to convey 7,500 passengers per day in either direction, corresponding to a minimum yearly output of 40-50 million individual journeys. It is however intended eventually to increase the size of the trains to six cars, while the possibility of reducing the intervals of service below two minutes might also be considered.

Advice Hard to Follow

THE church was packed, even the aisles lined with chairs. Just before the benediction, the thoughtful clergyman, who loved order as he did the Gospel, thus admonished his hearers

"In passing out, please remain seated until the ushers have removed the chairs from the aisles."—*Lippincott's.*

Vast Forest of Crystal Trees

The Wonderland of Arizona's Petrified Forest, Formed While the Earth was Young

By GUY E. MITCHELL
Secretary, National Irrigation Association

A WONDER of the world is the great Petrified Forest of Arizona. It is of as enthralling human interest as the great cataracts, caves, and canyons of the Western hemisphere. It is of intense interest to the scientist, who in these stone trees catches a glimpse of the world when it was yet young, and seeks a clew to the solution of some of the mysteries of nature—for this forest is older than the human mind can conceive.

The Government of the United States has taken the forest under its care. At the last session of Congress, it was set aside as a government reservation. The reserve embraces roughly 5,000 acres, useless for agriculture, and devoid so far as known of mining value, but of incalculable worth in stimulating broader and higher thoughts in plain people and furnishing a text for study, exploration, and speculation on the part of men who by means of geology would unravel some of the secrets of the world's past.

SENTINEL OF THE ARIZONA PETRIFIED FOREST.

This garden of monuments to the vegetation of bygone ages is covered with wood which, by the chemistry of the Creator, has been transmuted into stone. In some places there are trunks of trees a hundred feet long, prone upon the ground, lying as they fell when the earth was young. Huge logs, broken into sections, lie in confusion about the park. One cannot walk without stepping on bits of stone-wood. Everywhere is found the curious material. The wreckage of this one-time stately forest of living trees varies from bits the size of a marble to blocks and logs eight to ten feet thick. Much of this great exhibit rests upon the surface of the ground; some is buried so as to be out of sight; and much is only partly inhumed, so that from the shale project stumps, trunks, and branches of what once upon a time were trees that gave shade and shelter to strange animals long ago extinct, which roamed that part of the earth before man was born.

The country of these stone woods is *mesa* or table land, *mesa* being the Spanish word for "table," and all that western region being under Spanish dominion before the United States obtained title by conquest, discovery, or purchase. These mesas, even without the attraction of the fossil forests, would be interesting to the palæontologist, geologist, geographer, or anyone who marvels at scenic beauty. They are of shale, clay, and sandstone of many colors. They have been eroded by wind, grit, and water till shaped into forms of bizarre beauty. Looking on this strange scene appalls one with the suggestion of the countless ages that must have passed while this erosive process has been under way.

In telling of the origin of the forest, a writer of scientific attainment has eloquently said

"Once they were a forest of stately pines grown to a height far beyond that attained by the trees of to-day. Ages passed; and through some unexplainable act of nature, they were uprooted, prostrated to the ground, probably buried beneath the earth by volcanic ashes and the snows of countless winters. Next came the waters of the floods, leaving over the prone giants an inland sea, and all traces of the green forest were swept away. Vast periods of time passed; the seas vanished; volcanoes sent their ashes high in the air, and explosions from the interior of the earth swept upward the debris, among which were the wrecks of the pines. Following this period, the waters hurried toward lower levels, gnawing the masses and endeavoring to eat into the very cell structure of the logs. Erosion was at work; and after centuries, through the probable action of acids and alkalies, the logs of the ancient forest are revealed to the human eye. But they are no longer wood. They are changed into logs of adamant."

PETRIFIED TREE TRUNK SERVING AS A BRIDGE.

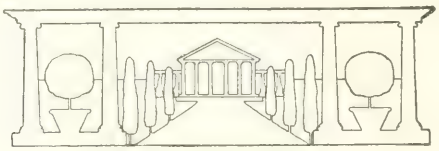
Not all the petrified forests of the United States are to be found in the Arizona reservation. Large deposits of petrified wood occur in various other sections of Arizona, as well as in New Mexico and Utah. There are large deposits of petrified wood in the Yellowstone National Park, and in parts of Wyoming and California. But the remains of Arizona's Petrified Forest are the most numerous, representative, interesting, and above all the oldest. Its stone-wood is older by millions of years than that found in the Yellowstone country and in Wyoming and California. Nor is there any other place where the petrified wood assumes so many varied and wondrous forms and colors. The wood of the "Forest" is often so beautiful and so hard that it may be classed with precious stone. Much of this mineral formation passing through Nature's laboratory has been converted into chalcedony, opals, and agates, and some of it closely resembles jasper and onyx. Sections of it are so hard that from them may be made an excellent quality of emery.

The coloring in this strange matter would cheer the eye of an artist. In it is to be seen every shade of black, red, yellow, blue-purple, and lavender, but each piece is distinctly—or *was* distinctly—wood, for the grain and the knots show clearly. The chips which litter the ground seem as heavy as lead, and are as hard as steel and as dense as flint. The

PETRIFIED LOGS FROM WHICH EARTH HAS BEEN WASHED.

agents of the Government permit visitors to carry off small fragments, but the removal of large blocks is forbidden. There was a time when teams hauled this wood away for exhibition purposes and for use as ornamental stone. Though the supply of the stuff is apparently inexhaustible, yet the Government feels that it is acting wisely in preserving the forest as much intact as possible. The Petrified Forest is to be enjoyed by this generation, and preserved for and handed down to posterity.

Perhaps the focal point of interest in the stone forest is the Natural Bridge. The bridge is a giant, petrified trunk which lies obliquely over a little canyon thirty feet wide and twenty feet deep, the distance to be traversed on this footbridge being 44 feet. The log is ten feet in circumference, and the visible length of the tree of which it is a part, is 111 feet. It is longer than this, but only this length is visible, for one end of it is deep-buried in shale and sandstone. Recently the bridge has given signs of disintegrating, for petrified wood is brittle and apt to crack. The Government, to preserve the bridge, has built two stone abutments to support it, so that at present the bridge has three spans.



The Retort Courteous

GENERAL GREENE, of Rhode Island, is credited with a prompt and telling retort to the somewhat cold and pompous Russian, Count Gurowski, to whom a common acquaintance abruptly introduced him at Newport. The Count, without expressing by word or gesture any pleasure in making the acquaintance, peered slowly over his green spectacles at the General, and said very quietly: "I believe you have a great many generals in this country." "Yes," replied Greene, bowing, "almost as many as you have counts in Europe."

Seen at the Automobile Shows

Cheapest and Most Expensive Pleasure Vehicles Huge Trucks and Tiny Delivery Carts—Automobile Luxuries and Novelties

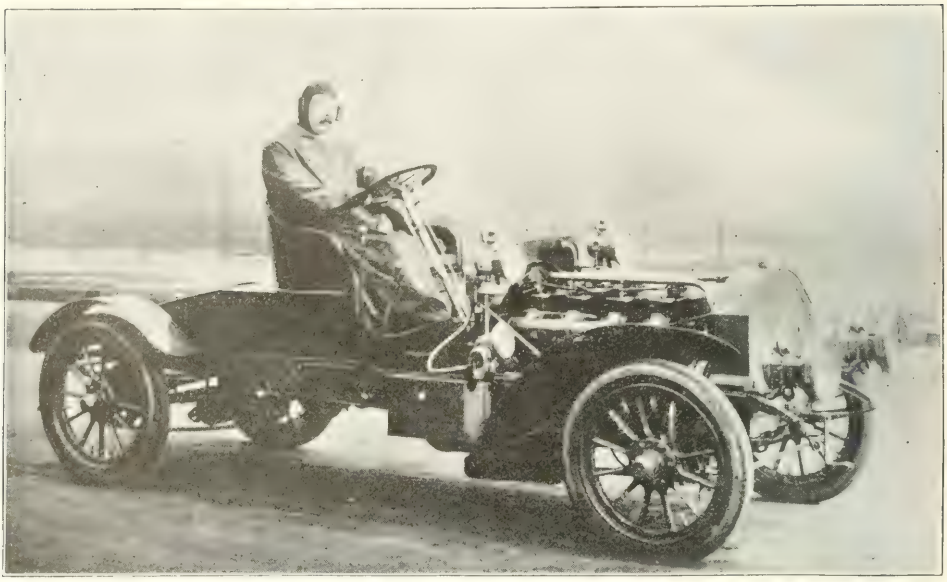
By DAVID BEECROFT

Associate Editor *Motor Age*

THE smallest and cheapest pleasure vehicle exhibited at the recent automobile show in Chicago was the Orient buckboard, a product of the Waltham Manufacturing Company. This little machine—which sells for $400—is not an innovation of the present season, but has been an accepted vehicle for the last three years. It is capable of carrying two passengers at the rate of 35 miles per hour on rural roads and at the remarkable low expense of four-sevenths cent per mile—the machine making 35 miles on one gallon of gasoline, which in most places retails at 20 cents a gallon. It is fitted with a three and one-half-gallon gasoline tank, so that the tourist has on hand, with full tanks, a fuel supply for 125 miles. To this must be added, of course, the pittance of oil needed, one pint sufficing for 90 miles, making the lubricating expense but 1 cent for each 15 miles traveled. Notwithstanding its speed abilities and the slight expense of operation, the machine weighs approximately 550 pounds and measures 80 inches in length from axle to axle. Its power comes from a single-cylinder, 4 horse-power, air-cooled, gasoline motor, placed vertically above the back axle, a feature which makes the rear view of this machine resemble, to a remarkable degree, the front view of its many big brothers. To aid in cooling the motor, a three-blade rotary fan, driven by a belt, is placed in front of it, directing a constant draught of cold air on its surface. The power is taken from the motor through a friction disc on the front end of the crankshaft against the surface of which disc bears a friction wheel carried on a cross-shaft. In the ends of this cross-shaft are sprockets for the side chains to the rear wheel hubs, as

ORIENT BUCKBOARD.

Price $400. Cheapest pleasure vehicle at the Chicago Show.



APPERSON 95-100-HORSE-POWER RUNABOUT.

Price, $11,500.—Most expensive automobile of domestic manufacture seen at Chicago Show.

shown in the illustration. The wheels, almost bicycle in character, are 26 inches in diameter and carry pneumatic tires two and one-half inches in diameter. The control of the buckboard is simple: To the front of the seat is a lever with handle grip, and by a right or left movement of this lever the steering is accomplished; at the left of the seat is a lever for changing the speeds; and pedals for braking are in the footboard. With a top the buckboard is well suited for all-year use. To the rear of the seat is a convenient compartment for carrying baggage.

Most Expensive American Car

Both money and brains have made the automobile within the last decade the speed king of the world. For years the steam locomotive was supreme; then came the electric trolley car in Germany, which attained a speed of 128 miles per hour; and now, within the last month, has come to the front the fleet motor car with its speed of almost 129 miles an hour. Perhaps the fastest runabout car yet constructed in America, if not in the world, is the Apperson, a Hoosier vehicle, built by the Apperson Brothers Automobile Company of Kokomo, Ind. This car, with a market price of $11,500, is the most expensive domestic machine, as well as one of the speed kings. Its power comes from a 95-100-horse-power, four cylinder, gasoline engine carried in the front of the car just in rear of the front axle and entirely in front of the dashboard. The driver sits almost midway between the front and back road wheels and controls the machine through many pedals and levers. In front of him is a steering wheel, a right movement of which turns the front wheels to the right, and a left turn produces the opposite movement. On this wheel are two little levers that can be worked by his fingers, by which the speed of the engine can be varied from 100 to 1,500 revolutions per minute and whereby the car can be made to travel at almost any desired speed. To his right is a pair of levers, one for applying brakes for stopping the car, and the other for changing the speed of travel by altering the gear reduction between the crankshaft of the motor and the back wheels. From head to stern the car is strongly built, being made almost entirely of steel, except the body, and weighing 2,500 pounds. It can make 75 miles an hour with ease on roads where straight stretches are possible, having done as high as 65 miles around its native town. This means that on ocean beach stretches, such as Florida affords, the car

could make 80 or 85 miles per hour. It measures 10 feet from front to rear axle, and has wheels 34 inches in diameter, each carrying pneumatic tires 4½ inches in diameter, a set of them costing $280.

A Disappearing Runabout Seat

A vexed problem with motorists who have made it a point to do considerable touring in the summer months, has been the taking along of a competent mechanic to make little repairs, replace tires, and clean the car up at each stop. Where to carry the mechanic without adding a large rear seat, was the problem. A custom originated in Germany and other foreign countries for the mechanic to sit on the footboard at the left side with his feet on the steps. This was all right for ordinary traveling, but with fast speeding over rough roads the danger of the mechanic being thrown off was so great that for American purposes the custom was not accounted a safe one. The rumble seat has been brought out as the solution. It is a single seat behind the front seat, and assumes a variety of forms. That adopted on the two-passenger roadster of the Pope Motor Car Company, Toledo, O., is of the folding type, so that when not in use it is enclosed within the rear compartment of the body. The seat is secured to the under side of a lid to this compartment, so that when the lid is opened and thrown back, resting on the remaining portion of the cover, the seat is brought into an upright position, and ample foot-room is provided in the front part of the compartment. To aid the mechanic in holding his place, two hand grips are provided, one on each arm of the seat, and two others are fitted to the back of the front seat. This rumble seat adds but little weight, gives excellent accommodation for the mechanic, produces an attractive rakishness to the body design, and, if not needed, folds away, leaving the body an out-and-out runabout.

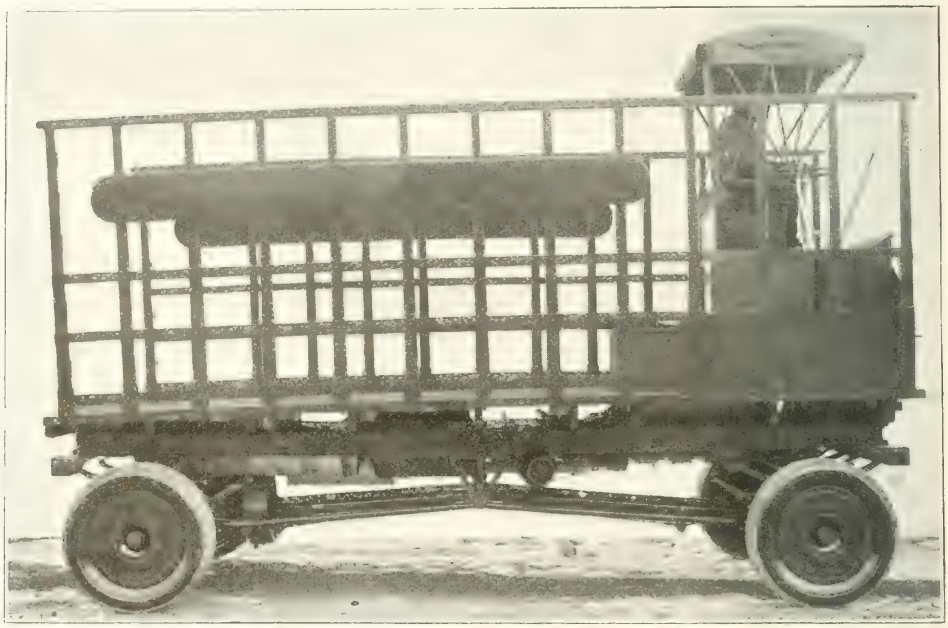
Largest of Commercial Autos

Horseless Town is no Utopian dream if the Automobile Show can be taken as criterion of the advancement made in automobile trucks, automobile drays, and automobile delivery wagons. A few years ago the motor wagon was a curiosity, now it is invading the big cities by the score, and in Old London is fast supplanting the horse. American motor trucks, while not so numerous, are nevertheless up-to-date in every respect; and one of the leaders is what has come to be known as the Four-Wheel Drive, a massive machine built by the Four-Wheel Drive Wagon Co. of Milwaukee, and capable of carrying over any roads a load ranging from six to ten tons. This truck differs from all others of its class in that all four of its road wheels are caused to revolve from the gasoline motor; and so the four of them aid in pulling the car with its load, the result being that the

Pope Rumble Seat.
Can be folded downward out of sight.

truck is capable of manœuvering with much heavier loads than those where only the two rear wheels do the driving. Still another point about this machine is that the four wheels are turned to right and left for steering the truck, instead of the front two wheels only. This allows of turning in close quarters. This massive truck uses wood tires in place of rubber, the latter wearing very rapidly when heavy loads are carried over cobblestone pavements. The tires and the spokes are the same, so that when tires are replaced, a new set of spokes, as it were, is also installed. It is surprising, with a big machine like this, that ball

bearings should be used in the road wheels, but these have proven most serviceable because of the large size of balls used. The ability of a machine of this class is nothing short of colossal. In tests it has pulled 44 tons consisting of an 8-ton load it carried and a flat car loaded with 36 tons of stone. In other tests the truck has been loaded with 6 tons and the wheels backed close to a 13½-inch street curb, when the power was turned



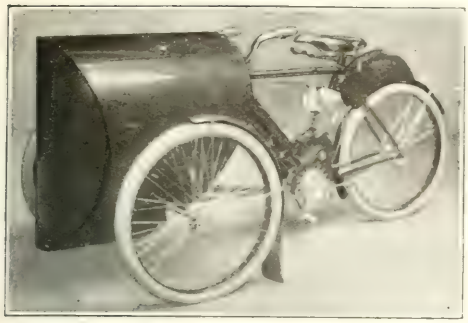
LARGEST COMMERCIAL AUTOMOBILE MADE IN AMERICA.

Four-Wheel Drive Wagon Company's truck. Has wood tires, and drives and steers by the four road wheels. Load, 6 to 10 tons. Speed, 2 to 15 miles per hour.

on and the machine mounted the curb without sticking. Immense loads have been carried at a speed of ten miles per hour. On rough places the speed is eight miles, or as low as two in crowded streets. From repeated months of service it has been found, by keeping account of the gasoline and oil used, and the necessary repairs, that a machine of this character will do the same work as five two-horse teams at about half the cost.

Smallest Commercial Auto

Ten years ago, when the delivery boy carried a reasonable express load on his shoulders while he manœuvered through crowded streets on his bicycle, there was little indication that the future contained a metamorphosis of this two-wheeler, and that now many big firms would be using what are called tri-cars for light and speedy delivery work. Tri-cars are little three-wheel machines with two wheels in front between which is carried a large oval-shaped carrying space. To the rear of this compartment is a single wheel, used for driving purposes the same as the back wheel in a bicycle. The power for locomotion is a little 3-horse-power air-cooled motor carried in the seat post and from which a chain transmits the drive to a sprocket on the rear wheels. One of the leading makers of this type of tri-car in America is the Aurora Automatic Machinery Co., Aurora, Ill., which has numerous models. The machines will carry a load of 350 to 500 pounds and can travel as high as 25 miles an hour. The peculiar advantage of them is the facility with which they can negotiate crowded business streets, threading their way with much greater speed than four-wheeled machines. The control of the car rests in the handle grips, a turn of the grip to the right starting the motor



TRI-CAR DELIVERY
Smallest commercial vehicle at Chicago Show.

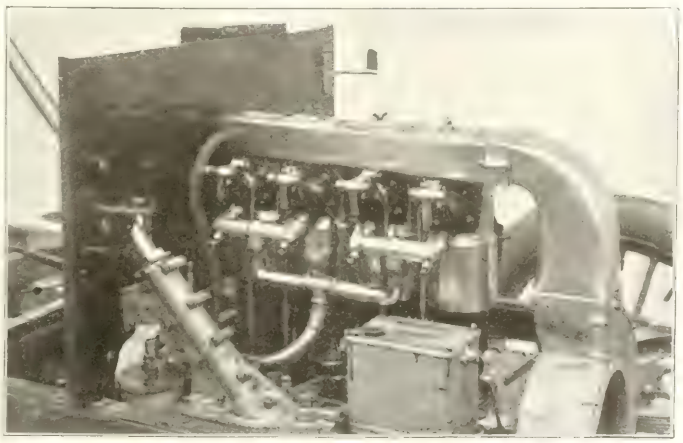
and an opposite turn reducing its speed. Steering is through handle bars, brought down from bicycle times, and braking methods are similar. Several makers replace the carrying compartment with a wicker seat, converting the machine thereby into a most comfortable sight-seeing vehicle, one largely used in the parks and boulevards abroad.

Frayer-Miller Air Cooler

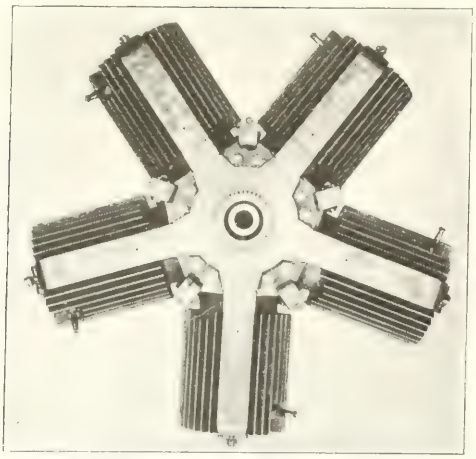
Whether it is best to cool the cylinders of automobiles by water or by air is a much mooted question among motor car manufacturers. Eighty per cent of the makers use water, circulating it within a jacketing which encloses the cylinder walls, and maintaining the flow of water by a gear-driven pump with a radiator of cellular structure for cooling the water. The adherents of air cooling, in general, use flanges or radiating pins in the cylinder walls, the presence of which doubles the area of the walls and also doubles the cooling possibilities. The Frayer-Miller engine, coming from the factory of the Oscar Lear Automobile Company, Columbus, O., dispenses with both of these accepted designs, and places over the cylinder walls a very loose-fitting aluminum hood or cap which extends half-way down the cylinder walls and encloses the heads of the cylinders as well as the walls. Into the space between this jacket and the cylinder wall is injected a strong current of air, generated by a rotary blower, similar to the ordinary electric fan, carried at the front of the motor. From this blower, large-size aluminum pipe, of square section, passes along over the tops of the cylinders and has a branch passing to each cylinder. The cool air enters at the cylinder head where the walls are hottest, and after passing down the walls escapes through an open space at the bottom of the jacket. The necessity of good means of cooling automobile cylinders is apparent from the fact that the average temperature within the cylinder when the gasoline mixture is being exploded is 2,000 degrees, which, however, falls rapidly after the explosion and ascends as rapidly immediately preceding the following explosion. The Frayer-Miller blower casing is open at the front for the free admission of air when the car is traveling; but the cooling facilities are such that with the car stationary, within a building, the blower creates sufficient draught to keep the cylinders at a working temperature.

Adams Revolving Motor

Doing things in opposition to accepted rules has ever been the aim of many, and will ever continue to be. In motoring, a field rich in individuality, this is especially the case, and in no respect is this more apparent than in the peculiar designs of motors for propelling gasoline



FRAYER-MILLER FOUR-CYLINDER ENGINE



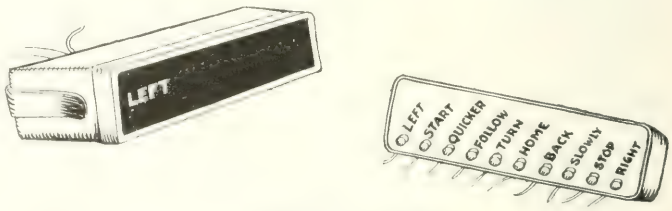
ADAMS FIFTY-HORSE-POWER FIVE-CYLINDER REVOLVING MOTOR.

machines. The Adams Company of Dubuque, Ia., has undoubtedly excelled in this respect, and has produced a motor that, while unique in the extreme, has proven itself a capable machine for the last seven years, although it has but recently been put on the market. The motor has five air-cooled cylinders arranged as the spokes would be in a five-spoke wheel. The steel crankshaft corresponds with the axle carrying the wheel, and contrary to all practice remains stationary, while the cylinders revolve around it as do the spokes in the wheel. In each cylinder is a trunk piston connected through a rod with the crankshaft, which has but one crank throw, the five pistons being connected to it. Supposing that this throw is upward, then as each cylinder comes to the upward position the piston will then be at the outer end of the cylinder, and when directly opposite to this will be at the inner end of the cylinder; thus once in each revolution does the piston in each cylinder go from the inner to the outer end and back again. The motor generates 50 horse-power when it is revolving 900 times per minute. Because the cylinders revolve, the use of a fly wheel is obviated and the motor weight thereby reduced a couple of hundred pounds. The motor is carried in the back of the automobile body much as a wagon wheel would lie on its side on the floor. It is, however, well anchored in position so that when revolving at as high as 1,000 revolutions per minute all danger of it breaking loose and demolishing the body is eliminated. The motor uses gasoline as a fuel, and has its mixture supplied and ignited in much the same manner as the regular automobile motors where the cylinders are carried upright in front and remain stationary while the crankshaft to which the pistons are attached revolves.

Cars fitted with this motor have made the mile in one minute, and in general appearance cannot be distinguished from the regulation motor vehicle.

A New Auto Luxury

The speaking tube by which the passenger in a hansom or cab communicates his or her commands to the driver is being replaced in the automobile world by what is termed an "annunciator." Like many other of the refinements in the automobile, this device hails from abroad, claiming Paris as its native heath. The annunciator consists of two distinct parts, one a keyboard carried within the enclosed part of an automobile where the passengers ride, in some convenient location to the seat. On the keyboard are six, eight, or a dozen keys with directions such as "home," "right," "slow," "left," "pass," "stop," etc., beneath the corresponding keys. On the dashboard of the car is a similar keyboard with directions but minus the keys. This keyboard has a glass cover and is in plain view of the driver, so that without effort his eyes are constantly upon it. The two keyboards are connected by electric wires with a current furnished from a set of dry cells



ELECTRIC ANNUNCIATOR.
For delivering commands to chauffeur. Operating keyboard at right. At left is shown board on which signal appears.

carried beneath the seat. A pressure on one key in the keyboard by the occupant lights a miniature electric light below the corresponding direction on the keyboard in front of the driver, so that the particular command is illumined while the remaining ones are dark, and, should the light not be sufficient to attract the attention of the driver, a bell connection is furnished, so that simultaneously with lighting the light commences the ringing of a bell which cannot fail to attract.

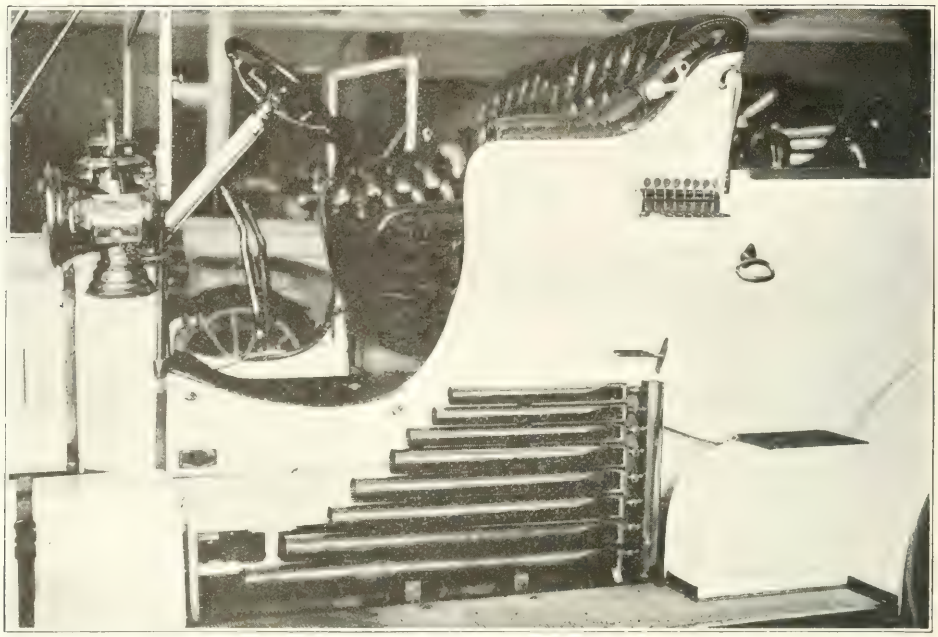
Electric Horns for Autos

No greater novelty in the automobile horn department has been received this season than the introduction of an electric horn, which takes the place of the bulb horn so generally in vogue on motor cars. The rubber bulb horn has its many disadvantages, notable among which is the removing of the hand from the steering wheel of the car to press the bulb. Drivers of cars are familiar with the difficulty experienced in operating the horn, a very quick pressure being essential to produce a tone, which is often attended with difficulty in cold weather. The electric horn introduces nothing new in the electric field, being designed according to accepted principles. The sound-producing medium is a vibrating diaphragm, the same as used in telephones. To vibrate the diaphragm an electric magnet is required. Two wires from a small storage battery connect with the coil windings of the electro-magnet and a vibrator serves to make and break the current. The vibrations of the vibrator are communicated to the diaphragm through a small plunger rod which is shown surrounded by a coil spring. Each time the circuit in the electro-magnet is completed, the vibrator is drawn toward the magnet and the push rod thrust against the diaphragm, but immediately the circuit is broken the vibrator falls back and the coil spring pulls the plunger rod away from the diaphragm. The diaphragm is protected by a non-vibrating diaphragm of fiber between it and the electro-magnet, and at the inner end of the horn portion is a mica diaphragm carried in a rubber framework, which prevents dust or moisture reaching the metallic diaphragm and interfering with its sound-producing qualities. A suitable covering fits over the electro-magnet, rendering the whole horn mechanism dust-proof. For automobile use the horn is mounted in any convenient place on the car, and the battery carried beneath the seat. The wires from the battery to the horn pass up the center of the steering wheel post, and on the rim of the wheel is a switch which can be operated by the finger without taking the hand off the wheel. The sound produced differs slightly from that of the bulb horn, yet the blast has a decidedly musical tone. The Vesta Accumulator Company, Chicago, Ill., is the manufacturer.

VESTA ELECTRIC HORN.
Showing covering removed, and electro-magnet for vibrating the diaphragm that produces the sound.

Auto Horn Plays a Tune

An attractive substitute for the automobile signal horn is the Gabriel eight-horn chime, made by the Gabriel Horn Mfg. Company, Cleveland, O. This musical instrument, for it is nothing short of such, as the illustration shows, consists



GABRIEL EIGHT-HORN CHIME ATTACHED TO TOURIST CAR.

of eight horizontal pipes of different diameter and different length, the eighth, or bottom horn, being more than double the length and diameter of the small top one. These pipes connect with a common vertical end pipe, or header, into which the exhaust gases from the motor are conducted by suitable piping, there being a controlling valve operated by pedal in the footboard of the car, so that, when desired, the gases can be allowed to enter the end pipe, whereas otherwise they pass direct to the car muffler and then to the outside air. Above the pipes is a keyboard of eight keys corresponding with the eight pipes and wires connecting the keys with stops controlling each pipe. By pressing a key the stop to the corresponding pipe is opened and the gases permitted to enter, producing one note. Having eight pipes, a complete octave, it is possible to play several simple airs on this chime. A feature of the chime is that the tones produced are irrespective of the speed of the gasoline motor, so that the sound is as clear and of the same tone when the exhaust pressure is one pound as when much higher, a condition accomplished by a special spring-controlled valve mechanism. The construction of the eight pipes is identical with that of the pipes in a pipe organ, there being neither reeds nor bulbs to become deranged, the vibration of the column of air within the pipe alone producing the tone. The eight pipes are made of proper size to give the consecutive notes of the octave. Exhaust pressure from a steam engine is as efficient as the exhaust from a gasoline motor, and a one-cylinder car gives as good exhaust pressure as a four- or six-cylinder machine.

Life Stories of Successful Men

EZRA BUTLER EDDY

By ALBERT R. CARMAN

WHEN a man makes matches, it is not surprising that he should suffer from fire. Still there are men—and metals—who can hardly be said to "suffer" from fire. They emerge from the flame with much gone that had been thought essential; but the world is the better aware of the amount of pure metal that underlay it all.

In the spring of 1900, a great fire swept over Hull and Ottawa—the two Canadian cities that face each other across the Ottawa river, one in Quebec and the other in Ontario—and the magnificent collection of mills and factories owned by the E. B. Eddy Company was obliterated. Mr. Eddy was at this time over seventy years of age; and even those who had had the greatest faith in him through the long years of struggle when he had been building up his vast enterprises, feared that a finishing blow had been struck. Hull lay in ashes; a section of Ottawa was gone; relief funds were being subscribed all over the civilized world; and food was being served out to the homeless people in doles.

Fire Only Cleared the Way

But Ezra Butler Eddy, with more than seventy years on his shoulders and with the twisted wreckage of his machinery lying among the blackened timbers of his mills, is said to have gone to the banks and told them that this fire had only cleared the way for improvements he wished to introduce and had set him free to branch out in new directions. Making a statement of his affairs, he asked for financial backing. Certainly he got it; for the Eddy mills went up again in disheartened Hull, better equipped than before; and the twin cities responded pluckily to the Eddy leadership in industrial advance, as they had on many occasions in the past.

This indicates a prominent Eddy characteristic—pluck. Mr. Eddy seems never afraid of his own future. And with this pluck, he has that happy *sang froid* which is so dear to the heart of the romancer. Another fire incident illustrates this. He was away from home at one time when a great fire broke out in his mills—fires have been common experiences of his. His manager—so the story goes—telegraphed:

"Great fire in the mills. What shall we do?"

To which Mr. Eddy replied by wire:

"Put it out."

Born in Old New England

No one will be surprised after this to learn that Mr. Eddy is of New England birth, having been born on his father's farm near Bristol, Vt., August 22, 1828. His mother, Clarissa Eastman, was a direct descendant of Miles Standish, though his father's ancestors came from Scotland. He began his business career in New York City; but soon came back, in 1851, to Burlington, Vt., where he commenced the manufacture of friction matches. Since that time he has extended his connection to include most industries using wood as raw material; but he is yet a match-maker, though the striking of them produces an odor which excites doubts as to whether he makes his matches in heaven. As a matter of fact, he makes them in Hull.

After three years in Burlington, he removed to Hull, where he could utilize the magnificent water power of the Ottawa river and be almost in the heart of an

NOTE.—Mr. Eddy died early in February, after this sketch had been written.

inexhaustible supply of the finest timber in the world.

From this time forward, the history of Mr. Eddy is practically the history of Hull. He may be described as the man who made Hull; for though he has had excellent help, he is the one who has never lost faith, who has stayed there through all kinds of fortune, who has never permitted fire—that terrible foe of a lumbering city—to drive him to safer ground.

Makes Many Things from Wood

The recital of what his original industry has grown to, would turn this article

E. B. EDDY.

into a catalogue. He no longer merely saws lumber and makes matches, but turns wood into almost as many things as are to be seen in the shops. One of his largest departures is to take wood pulp and turn it into paper, on such a scale that the Eddy paper mills are among the most notable on the continent. No commercial tourist thinks that he has "done" Canada now until he has been over the Eddy works. They had this standing before the fire of 1900, and they have it again to-day.

And it is "Eddy" who has done all this. His lieutenants are the first to admit—even when they are modifying his orders—that the policy and the leadership are his. He has what might be called a departmental mind—a mind which delights in running a variety of industries each of which an ordinary man would look upon as an engrossing occupation. But, on the other hand, he seems to confine himself to his own group of industries. Some men are distinguished by the number of companies upon whose directorates their names appear. Mr. Eddy seems to be practically confined to the E. B. Eddy Company; but the E. B. Eddy Company does not feel itself to be confined to any particular branch of the wood-using business.

Rides Horseback and Blows Horn

One of Mr. Eddy's side-interests is a love of horses. He has a couple of large farms near Hull which are breeding and feeding places, and from which he draws some of the horses which are so necessary in his big business. Horseback exercise in the early morning has long been one of his ways of keeping in health under the terrific strain of his multifarious managements, accented semi-occasionally by a disastrous conflagration; and the boyishness of his buoyant personality used to be shown by his curious habit of carrying on these matutinal excursions an immense tin horn which he tooted merrily as he rode along the country roads. This, it will readily be believed, was more popular with the light-hearted old gentleman, greeting the new day with a canter and a cantata, than with the sleeping people along his road.

Only brief excursions has he made into politics, having served a session in the Legislature in the early seventies and acted as Mayor of Hull. But he is a frequent leader in philanthropic enterprises.

Raising a Hospital Debt

At the present moment, he is engaged in raising the debt on the Ottawa General Hospital. Some three or four years ago, he led a movement to complete and equip the new wing of the Hospital

which has nearly doubled its usefulness; and now he has set out to free it from debt. In this task, he does not shrink from the unpleasant labor of personal solicitation. He opened the ball by sending out circulars to all those who he considered should and could help; and then he started in to canvass those who did not respond. It was the application of his usual business methods to a philanthropic enterprise. He was not to be rebuffed by silence; he was not to be deterred by the unpopularity of a personal canvass on such a subject; he was not even frightened by the fact that there were sparsely settled country districts to cover as well as city streets. And the estimate that his fellow-citizens have of him is well indicated by the beautiful confidence they enjoyed, that the debt would be raised, as soon as they knew that "Eddy" had taken hold of the matter.

Always an Optimist

Mr. Eddy's strength does not seem, indeed, to be that commonest quality among the makers of great industries—the quick and sure perception of opportunity. It is true that he saw the possibilities of the Ottawa water power; but so have many other lumbermen. The force which has made his mills go when so many others have stopped, has not been water power but Man Power! And he is the Man who has supplied it. Pluck—an indomitable refusal to recognize the lineaments of the impossible—this has been the quality which has carried him ahead. He does not owe much to opportunity, but his debt to optimism is immense. He can even look on the bright side of a fire—a more difficult operation frequently than the words would imply. He spends years extending his business and building up a magnificent plant; from the arm-chair of over seventy he regards with legitimate satisfaction the work his hand has accomplished. A great fire comes and wipes it out. Next day, E. B. Eddy is not wringing his hands over his misfortunes; he is pointing out to the banks that this fire was really rather a good thing, that it cleared the ground for better mills and more modern machinery, and that they have only to back him to see a brighter plumaged Phœnix rise from the ashes. That is not opportunity-seeing; that is the sublime courage that rallies a routed army.

And it is a comfort to record this mainspring of success. Only the gifted few can have the far-sight; any man can refuse to recognize defeat.

Dinner-Pail Philosophy

¶ The best biographies are those on two feet.

¶ Even if you are only five feet high, stand up straight.

¶ The best remedy for a sluggish liver is not to be one.

¶ Some fellows have a vacant expression, even when they are thinking of themselves.

¶ It is because truth is stranger than fiction that a man makes up a little story to tell his wife when he has been out late.

¶ Be sure you are right, and then—take another look.

¶ There's one business that never pays—everybody's.

¶ Automobiles are numbered so that those who are run over may read.

¶ The reason why charity begins at home is because she's charity, and the reason why she usually stops there is because she is busy.

¶ Here is what you owe them:—Your mother took care of you, and your father paid the bills. You will never have such a snap again.

LITERARY

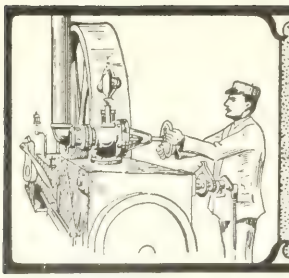
Ancestral Longfellow House near Newbury, Mass. Built by the first ancestor in America of Henry W. Longfellow.

Old Lowell House at Newburyport, Mass. Built by John Lowell, ancestor of the poet, James Russell Lowell.

LANDMARKS

Historic Hawthorne House at Salem, Mass. Birthplace of Nathaniel Hawthorne.

"Oak Knoll" at Danvers, Mass. Home of John Greenleaf Whittier.



ENGINEERING PROGRESS

Protected Third Rail

THE deadly third rail has met its Waterloo. Mr. E. W. Farnham, of Chicago, has devised a scientific and practical system of protection eliminating the danger of accidental contact with the energized feeder rail on electric roads, replacing the present dangerous exposed third rail and unsightly, overhead trolley wires, and affording also protection against interference with traffic by the elements—sleet, snow, and ice. With this protected third rail, no pole lines are required for the power circuits.

Fig. 1 shows at the left a rail section, set up without protecting cover; at the right is a section illustrating a complete installation with cover and cover-locks in place.

In Fig. 2, parts 2 are malleable-iron brackets securely fastened by lag screws to the ends of ties at intervals of 8 feet. These brackets are provided with deep pockets on each side, front and rear, in which are held the protection boards shown in cross-section, which are of sufficient length to extend from bracket to bracket, as is also the cover-board, all of which are held firmly in position by a single cover-lock bolted at the rear to each bracket. The special rail used in this system is of a U shape, provided with flanges at its two sides by which it is suspended from the brackets in a manner that effectively insulates it from the brackets, as also its protecting cover-boards, and at the same time permits it to move longitudinally for expansion and contraction.

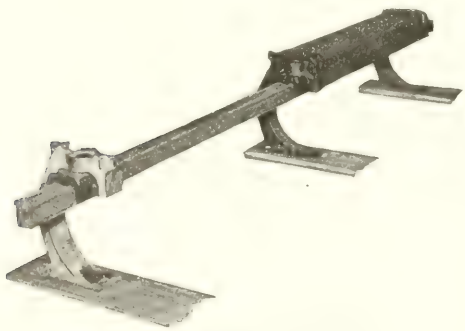


FIG. 1. FARNHAM PROTECTED THIRD RAIL.
Complete installation, with cover and cover-locks in place, at right; section without protecting cover, at left.

Sufficient allowance is made in the hanger to take up all the vibration and jar between the iron hanger and steel rail caused by the passing of trains upon the track rails. The method adopted for supporting the third rail is especially worthy of notice. The rail itself being carried by a malleable-iron hanger which is engaged by the hanger bolt, the bolt, passing through bushing insulator in the top of the bracket, as also through rail insulator 3, transfers the strain to the bracket through a compressional impinging of the bushing and insulator between the rail-hanger and washer underneath the head of the bolt. No amount of pounding or jarring can in any way interfere with this method. Any method, on the other hand, of supporting a rail in or by its own insulation, especially of a crystalline nature, under a weight tension, is a dangerous proposition, as the direct vibration, jarring, and pounding thrown upon the insulation directly between bracket and rail, quickly causes disintegration of the insulating material, and total destruction follows, thus permitting the rail to fall and make liable a very disastrous wreck to moving trains. Efforts to avoid these conditions resulted in the form now adopted. It was also found necessary to produce an insulator of the highest dielectric and mechanical strength for use with a third rail where

conditions are of such a dangerous nature. After long research, Mr. Farnham succeeded in producing an insulator of a fibrous, vegetable compound, which tests prove to be of the highest strength

E. W. Farnham.
Inventor of a Protected Third-Rail System for Electric Roads.

mechanically and dielectrically, thus perfecting a system of suspended rail from which a loss of power is absolutely impossible. Under its application in conjunction with the rail and bracket, there is no tensional strain upon the insulator. The insulator bushing is fitted into a cup cavity in the top of the supporting bracket. After the rail-hanger, insulator, and rail have been erected, this cup is poured full of insulating compound of the same character as the insulator, which eliminates all possible danger of a foreign substance causing a ground or short between the bolt, the rail-hanger, or the rail, through the bolt and the bracket, and at the same time prevents the bolt working loose.

The U-shaped form of rail permits the carrying of a bare copper wire for reinforcing purposes, thereby increasing the carrying capacity of the rail. These reinforcing wires are laid bare of insulation directly within the groove of the rail, and an extremely low resistance contact is made with the rail by the use of a compound plastic alloy bond at all rail joints, thus bonding the reinforcing wires and the rail joints at the same time. The rail itself is of very soft steel, made with a view to providing a conductor section of very high conductivity.

The cover of this case, upon the tested basis of many years' practice with railroads in the erection of snow fences, is so arranged at the back that snow moved by a high wind will be blown through from the face of the third rail, or blown over if coming from the direction of the back of the protecting case, thus leaving the space underneath the rail entirely clear from snow. The cover-boards are dipped in an insulating compound of a fireproof nature before being put in place.

The special type of carrier 12 and collector 13 gives a parallel motion at all times, and consequently a perfect contact

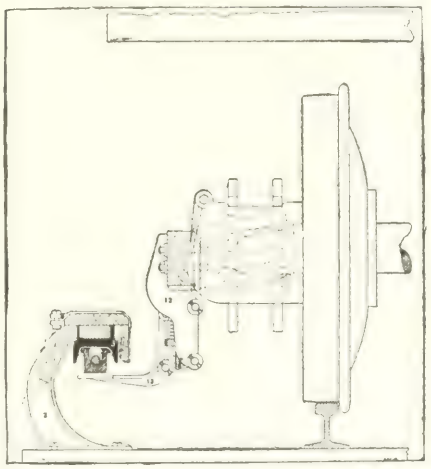
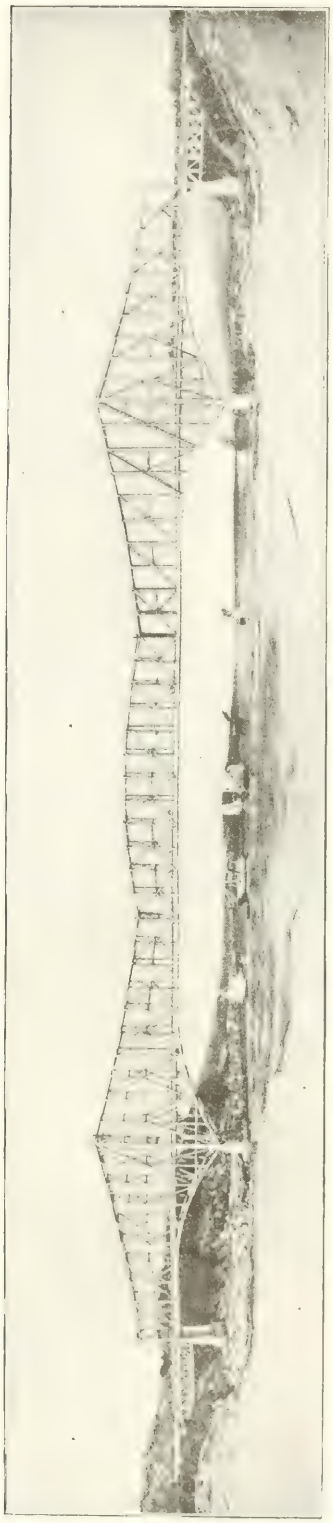


Fig. 2. Diagram Illustrating Car Attachments, Sliding Shoe, and Method of Operation of Farnham Protected Third-Rail System.

with the under surface of the rail, thus providing the highest delivery to the cars.

Passing through cities or towns, in streets and highways, the system provides an automatic self-take-up trolley, to which the contactor moves without interference with the movement of the car.

Mr. Farnham has also invented an electric power control, by the use of which any section of trolley or third rail can be cut out of circuit and left dead at all times when such section is not occupied by a car. This is adaptable for use in emergency cases on both trolley or third rail.



THE QUEBEC BRIDGE.

Containing largest cantilever span in the world. In course of erection across St. Lawrence river near Quebec. Will be open to all railroads. Total length of bridge, 3,300 feet; length of channel span, 1,800 feet; clear headway for navigation above high tide, 150 feet; height of cantilever towers above river, 300 feet; total width of floor, for double-track railway, with electric track, carriage highway, and sidewalk each side, 75 feet.

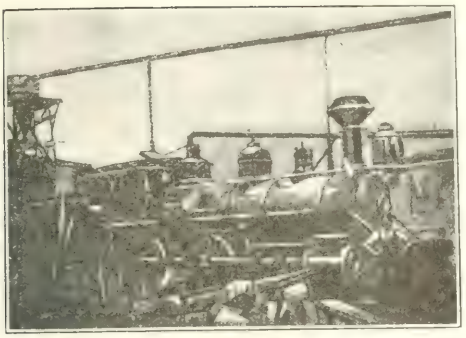
The new third-rail system is being installed on the Philadelphia & Western Railroad, covering forty miles of double track for high-speed and heavy traffic.

Longest Span in the World

ONE of the most remarkable bridges in the world, not only from the engineering point of view, but also from its relations as a link in transcontinental traffic, will be that now under construction across the St. Lawrence River, about 6 miles above the city of Quebec and 170 miles below Montreal. It will contain the longest span in the world, and will be the link that will render possible another all-Canadian transcontinental railway. The structure, it is supposed, will be built in two years. All railways will be entitled to its use. In order to avoid obstruction to ocean-going craft, the bridge is not built on a series of piers extending across the stream, but consists technically of two great cantilevers carrying a huge central expanded span having a total length in the clear—that is, between the towers at either side—of 1,800 feet, which is 90 feet longer than each of the two spans of the famous bridge over the Firth of Forth near Edinburgh, Scotland.

The approaches to the central span of the Quebec bridge are each 214 feet long extending from the shores to the supporting piers. All parts of the structure are of huge proportions, and consist mainly of built-up steel girders and other shapes, not a single casting being used. The weight of each girder is 278 tons. The anchor arms are 500 feet long. The bridge has a very large capacity, the floor having a total width of 75 feet. It is designed to carry two lines of steam railroad, two trolley lines, two carriage highways, and two sidewalks, the last-named being placed outside, and the rest of the traffic between the trusses, which are 67 feet apart, center to center. The clear headway above water is 150 feet.

It is only in recent years that the construction of such a bridge has been rendered possible, through the development in the manufacture of steel shapes. The steel mills are now furnishing rolled,



LOCOMOTIVE USED TO RUN A FACTORY.

rectangular steel in sizes that were not obtainable at the time the Firth of Forth bridge was built. As a consequence, the Quebec bridge is constructed with its cantilever towers in vertical planes. It will have built-up lattice chords and posts and 18-inch I-beams. The result will be a structure lighter in weight, cheaper in cost, and the most graceful in appearance among the bridges of the world. For purposes of comparison, it may be interesting to note that the span of the Williamsburg suspension bridge at New York is 1,600 feet; that of the famous Brooklyn Bridge, 1,595 feet; and that of the new Manhattan Bridge, 1,470 feet.

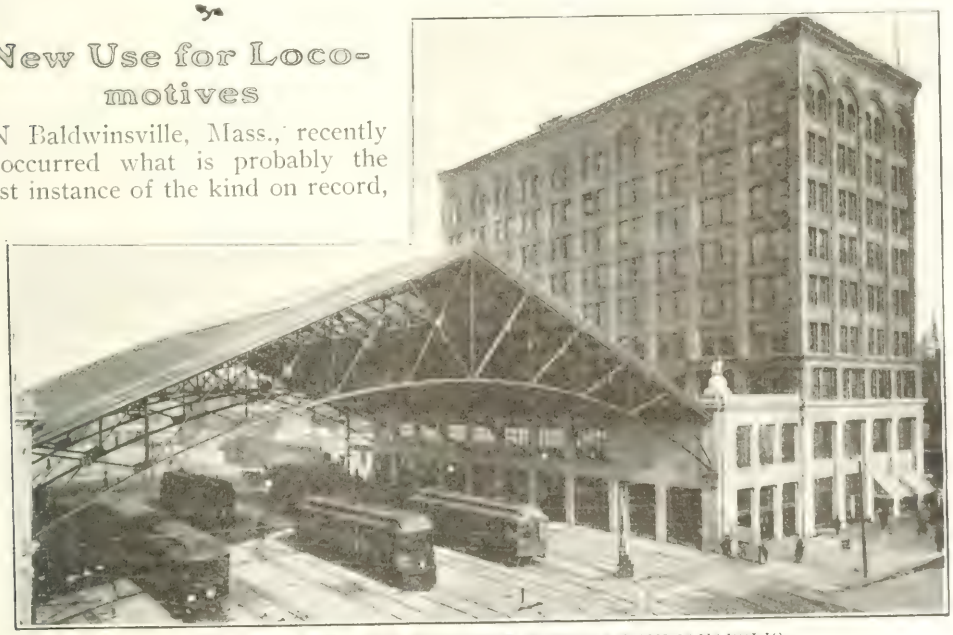
New Use for Locomotives

IN Baldwinsville, Mass., recently occurred what is probably the first instance of the kind on record, when a locomotive was employed to run a factory. The establishment had outgrown the power developed by its old plant of boilers; and, not wishing to shut down long enough to install a new battery, the proprietors conceived the plan of availing themselves of one of the surplus locomotives from the shops of the Boston & Albany Railroad.

The engine used, as shown in the accompanying illustration, was a small freight engine. It was sidetracked near the factory. The pipes leading to the cylinder heads were disconnected, and one of them connected to the steam dome of the locomotive, leading therefrom to the engine room of the factory. The plan was perfectly successful, and the establishment thus saved the loss which would have been incurred through inability to fill orders had it been necessary to lay off the men.

An Electric Railway Union Station

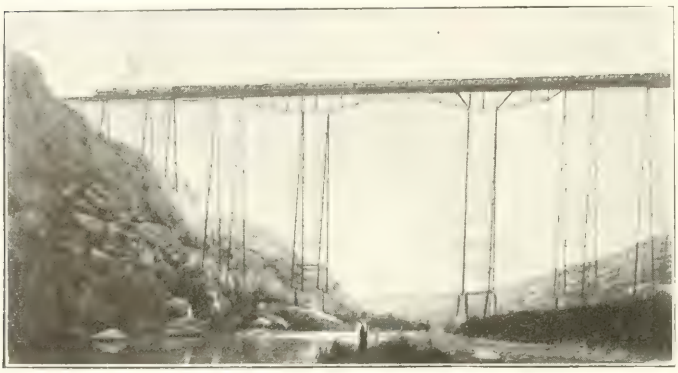
IN the development of the electric traction system of transportation as a competitor of and perhaps an ultimate substitute for the steam railway, no part of



UNION STATION FOR ELECTRIC ROADS AT INDIANAPOLIS.
Only building of its kind in the world.

the country has made more rapid progress than Indiana, especially the central part. Nine traction lines, with twelve terminal points and seven connecting lines, now meet in the city of Indianapolis.

So great did the traffic over these lines become that two years ago it was decided, at a meeting of the heads of all these roads, to build a union station in the heart of the city. Plans were made at once, a building site purchased in the business center of the city, and work was begun. In September, 1904, Mr. Hugh McGowan, president of the Indianapolis Traction & Terminal Company—the man who built the first street-railway in Indiana—had the satisfaction of seeing the end toward which he had labored for twenty years, accomplished.



BRIDGE OVER THE PECOS RIVER, TEXAS.
Highest railroad trestle in America.

Indianapolis is the center of the greatest system of electric traction lines on earth, with the first union station for electric railways in existence. The waiting rooms, ticket offices, restaurant, and all other essentials of a first-class station are located in the Traction Terminal Building, a handsome ten-story structure of pressed brick and Bedford limestone, which contains about 200 office rooms. Here also are the offices of almost all of the thirty traction lines of Indiana.

Between the building proper and the train sheds is the main waiting room. This part of the station is but one story in height, and is glass-roofed in order to secure better light to the traveling public. To the west of the waiting room are the train sheds. These are the same as those of any other station, with but one exception. The usual smoke-vents in the roof are omitted. As there is never any smoke in the station, they are not necessary. The sheds are built to accommodate nine tracks, and are wide enough to cover comfortably three large interurban cars. On account of new lines now building, the sheds will soon be widened so as to contain fifteen or more tracks.

During the first year of business at the new station, nearly 3,000,000 people were taken care of.

At the ticket offices, tickets are sold to over 100 points in Indiana and Ohio. The most distant point to which a ticket is sold is Columbus, Ohio, 188 miles away.

Facts show that the convenience afforded to the public by this station has given the passenger traffic over all lines into Indianapolis a great "boost;" and it is certain that in time all cities of any prominence in the electric traction field will follow the example of Indianapolis. —GEORGE FENGER.

America's Highest Viaduct

THE great height of this bridge can be realized by comparing it with the train of cars going across. In all, there are twelve cars on the train, besides two locomotives drawing it. The viaduct is the highest in North America. If one dropped a stone from the center of the bridge to the water beneath, it would fall 321 feet. The bridge crosses the Pecos river in Texas; and, besides being of great height, is 2,180 feet in length. So far as known, there are but two railroad viaducts in the world which are higher. One is the new bridge over the Zambesi river at Victoria Falls in South Africa, about 420 feet high; and the other the Loa viaduct in South America, which has a height of 336 feet.

"Which Branch of Engineering Shall I Take Up?"

No. V. Electrical Engineering—An Interview with Bion J. Arnold, Past President American Institute of Electrical Engineers

By JOHN L. RAY

Within recent years engineers have specialized along many different lines. The result has been the development of as many practically distinct branches of the profession. Doubtless there are young men, who having decided that engineering shall be their life work, are hesitating as to which branch they shall take up—Civil, Mining, Mechanical, Hydraulic, Chemical, or any one of a dozen other divisions.

The series of articles under the above head—of which this is the fifth—is intended to help them come to a wise and discriminating decision. The articles will be based on interviews with eminent engineers, each of whom will set forth the advantages and drawbacks of his own particular specialty. In the present instance, Mr. Bion J. Arnold, one of the foremost of America's electrical engineers, discusses the future prospects of development in the great field of Electrical Engineering as applied to transportation problems.

"THAT electricity will be used generally on our main railway terminals, and ultimately on our main through lines, for passenger and freight service, I am convinced; but I do not expect that the change from steam to electricity will be made for economic reasons, or that it will be made voluntarily by the railroads."

In this statement Mr. Arnold sets forth his belief in the probability of one of the greatest developments in modern engineering; and, coming from a man recognized as leading in the most effective electric railroad work now being done in this country, the statement should serve to outline in general the tremendous field that will be opened to electrical engineers trained to handle problems of transportation.

Mr. Arnold's belief in the future of electric railroading is calculated to encourage the young electrical engineer and the student considering such a profession, to share his confidence.

As he outlines the development, it will come—in fact, is coming—in stages, as follows:

Electricity as a substitute for steam is economically possible under conditions which require the moving of a large number of "units" at a practically uniform schedule, at equal intervals, within a limited distance. Such conditions are met in the great terminals of trunk lines, where there is constant shunting back and forth. Two of the great railroad systems of the country have recognized the superiority of electricity over steam, and are operating their terminals by the former.

What has thus been done by the New York Central and the Pennsylvania system in New York, probably soon will be done by the Illinois Central in Chicago—by that road especially for another reason, which Mr. Arnold explains, and by the other roads later.

With the terminals equipped for electric operation, another step in the development comes when the steam railroad begins to get control of the trolley lines that have been built paralleling its tracks and competing for its local business. This step in the development was prophesied by Mr. Arnold nearly two years ago; and the fact that the steam railroads now are buying up their competing electric opponents, bears out his forecast.

By this time the people will have become accustomed to the advantages of electrically operated trains—their freedom from smoke and from the inherent disadvantages of steam locomotion. A demand will grow for the substitution of electricity for steam—at least in cities. Gradually the roads will be operating by electricity to meet this growing demand

in cities. Such objections may prove effective soon with the Illinois Central on the Chicago Lake Front.

Ultimately—probably at some time still distant—the roads, having equipped their terminals for electric operation, having adopted electricity for their tracks within the corporate limits of cities, and having taken over trolley lines for suburban business and as feeders, will come to the use of electricity on their trunk lines, even though the steam locomotive will remain the most economical method of transportation.

"At first," said Mr. Arnold, "special reasons may cause the equipment of terminals with electricity. It may result from the voluntary act of terminal companies who see economy of operation in electricity under such conditions. Public pressure brought to bear in great cities to secure better service by the elimination of the objectionable locomotive, may cause it.

"In populous countries, railroads will either build new electric lines, or for their own protection will acquire those already built. They will take over the trolley lines which have been competing with them, and will operate them as feeders for their steam trains. I made this prophecy before the joint meeting of the American Institute of Electrical Engineers and the Institution of Electrical Engineers of Great Britain over a year and a-half ago, and the prediction now is being made good. The steam railroads are buying up their competitors.

"Thus gradually steam railroads will become interested in the management of electric lines, and in the end will become the owners of them. The public will become educated more and more to electric transportation and its advantages. It will be a logical step to the electric equipment of the trunk lines between cities which already have electrically operated terminals.

"The first trunk lines to adopt electricity will, naturally, be lines operating in a country of sufficient density of population to make electric equipment economic. When one road running between two cities has electrified its trunk lines, the other and competing steam railroads will be forced to meet this improvement to hold their passenger traffic. Some roads may be forced to drop passenger traffic entirely and to become freight roads, because of their inability to equip electrically. Freight service will undergo a change; and with greater density of population, creating conditions similar to those in Europe, there will be developed a class of freight service conducted in light and swiftly moving electric trains which can be divided quickly and distributed over the surface tracks of the smaller cities and through the underground systems that will ultimately be constructed in our great cities.

"The action of the New York Central and the Pennsylvania system in equipping electrically in New York, is an example of faith on the part of steam railroad managers in the ability of electricity to meet successfully the conditions of steam railroad work. They do not prove conclusively that electricity can meet all the requirements of trunk line and freight service; but it is my belief that ultimately the operation will be by electricity.

"A steam locomotive finds its legitimate field in the long trunk-line service where few but heavy trains are moved, at infrequent intervals, at high maximum but uneven speed. Power cannot be produced in a central station which can move these trains as economically as they can be moved by their own locomotives. The substitution of electricity for steam in these cases must be based on some other reason than economy.

"Undoubtedly there is in existence today water power along the rights of way of some roads, which could be used economically in the substitution of electricity for steam; but these are special cases, and only tend to prove the correctness of the statement that otherwise the substitution would not be economical."

A number of roads—among them the Chicago & Alton—are experimenting with gasoline motors for their suburban service, in the hope of perfecting an engine which will solve the question of quick stops and starts, which will be able to compete with the trolley, and which will be superior in that the breaking-down of one portion of the system will not result in a complete stopping of the whole.

Mr. Arnold does not look for any serious competition between the gasoline motor and the electric motor, and does not believe that the former needs to be taken into consideration as an element in the problem.

As a pioneer in the development of the single-phase alternating-current motor, Mr. Arnold spent $40,000 experimenting, without bringing his experiments to commercial perfection. The ideas in connection with which he did pioneer work have been taken up and successfully worked out by big electrical establishments, and he has adopted one of the motors for use in equipping the Sarnia tunnel, connecting the American and Canadian branches of the Grand Trunk Railroad. The tunnel railroad is being laid for single-phase motors of the Westinghouse design, capable of being operated by either alternating or direct current, but intended primarily for the former.

Here is another illustration of the engineer's statement that the terminals will afford the first opportunity for electrical operation. The tunnel is operated by a terminal company, although it affords the connecting link for the two branches of the Grand Trunk. The substitution of electricity for steam in the handling of cars in the tunnel became almost a positive necessity owing to the objectionable features—if not the danger—of steam power in the tunnel.

Mr. Arnold describes in brief the needs of the situation and the manner in which they are to be supplied, as follows:

"The St. Clair Tunnel Company owns and operates a single-track tunnel underneath the St. Clair river, between Port Huron, Michigan, and Sarnia, Ontario. Although owned by a separate company, it practically forms the connecting link between the Canadian and American divisions of the Grand Trunk railroad system; and its entire business consists in handling trains of this system.

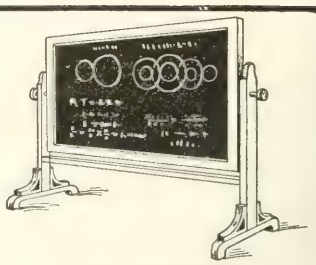
"The necessity for electricity in operating the locomotives which take trains through this tunnel, has been proved—notably by the lamentable accident some two years ago, when the breaking of a train in the tunnel caused the death of part of the train crew through suffocation by the accumulated gases. In electrifying the tunnel road, single-phase alternating current at 25 cycles per second and 3,300 to 3,000 volts' pressure will be supplied to the locomotive from an overhead copper conductor or wire suspended from a catenary suspension wire 22 feet above the top of the rail in the yards and the approaches to the tunnel. Each single locomotive will be capable of hauling a thousand-ton train through the tunnel in fifteen minutes, and each will have a tractive power of 50,000 pounds. These engines, though intended to be operated by the single-phase alternating current, are capable of being operated by the direct current."

"With the single-phase motor and the steam turbine a reality," Mr. Arnold said, "with the transmission problem almost solved, and with rapid development of the internal-combustion engine now taking place, we engineers are warranted in believing that we can combine these factors into a system which will ultimately supplant the steam locomotive in trunk-line passenger and freight service.

"For many years to come the steam railroad will hold its own in this country, and I do not anticipate that all roads will adopt electricity soon; but I do expect a remarkable development to begin soon in the electrical equipment of favorably located steam roads."

CHALK TALKS

by CARL S. DOW.



Number Twenty-Six—The Compound Engine

THE selection of an engine for a given plant involves a consideration of numerous conditions, not the least of which is economy. As fuel becomes more and more expensive, this feature is given greater prominence. Engineers design with great care and adopt many devices that aid materially in reducing the fuel bill. If the power is large and high efficiency is desired, a compound engine is generally chosen, for its many advantages make it preferable to any single-cylinder engine.

As the name implies, a single-cylinder engine is one having but one cylinder, and in this cylinder the steam is expanded.

A compound engine has two cylinders of different size. Steam is admitted to the smaller, called the *high-pressure* cylinder, and, after expanding a little, is conducted to the larger, called the *low-pressure* cylinder; and here the expansion is carried still further. The low-pressure cylinder must be larger than the high-pressure because the same weight of steam expands in it, but, being at lower pressure, it occupies greater volume.

The compound engine requires two cylinders, and in many forms has two connecting rods, two cranks, etc. This duplication of parts is of course expensive, but the increased economy of running more than offsets this. Let us see whence comes this economy.

Condensation

In the single-cylinder engine, the steam, after it has done its work, is at comparatively low pressure and temperature; and when it leaves the cylinder, the walls are cool, since they were in contact with this steam. As the fresh or live steam enters, it meets the cold walls, and immediately a considerable portion of its heat flows rapidly to the cold metal, a portion of the steam being condensed. The steam is still further condensed because it has done work, and when work is done, some heat is taken from the steam. About 50 per cent of the steam that enters is thus condensed. As soon as enough has condensed to warm the cylinder, the steam can exist in the cylinder as steam, even though it is very wet steam.

An investigation of cylinder condensation is very difficult because of the constantly changing conditions. It is, however, about proportional to the range of temperature, which is the difference between the entering and the exhaust temperatures.

The Compound Engine

If steam is admitted to the cylinder at 100 pounds' pressure, and is exhausted at atmospheric pressure, the difference in temperature is about 115 degrees. In the compound engine it may be admitted at 100 pounds, but the difference in temperature in either cylinder is only about one-half of 115 degrees, because the steam is allowed to expand but little, and when it leaves the high-pressure cylinder it is still at high temperature. The pressure in the low-pressure cylinder is not great; consequently the range of temperature is slight. This division of expansion causes much less cylinder condensation.

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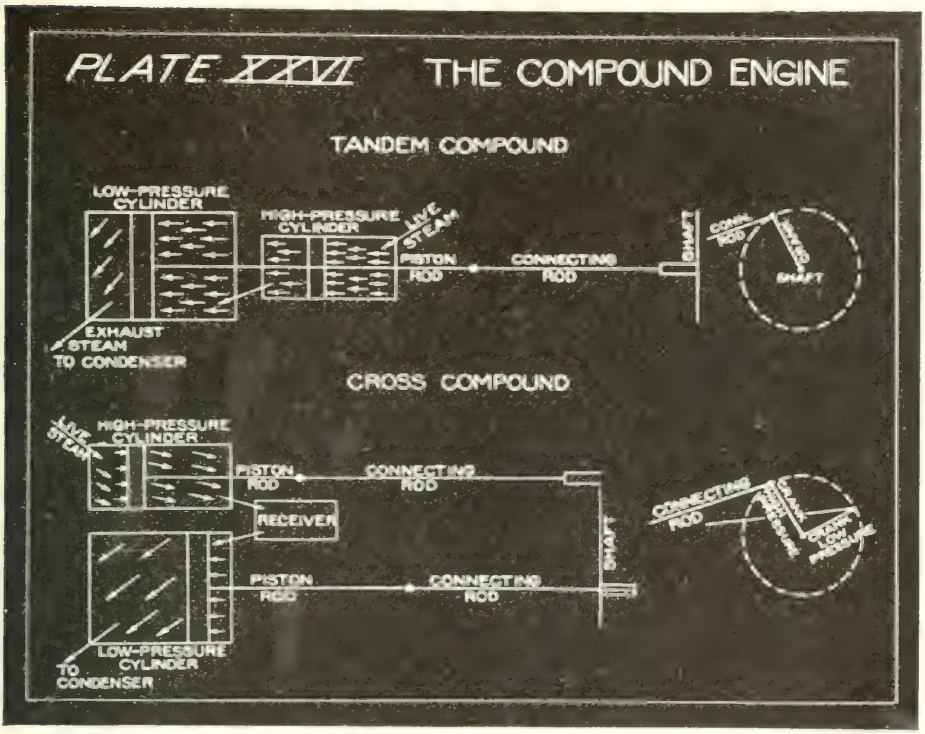


Some think a compound engine must be a large engine, but it may be quite small. The point to remember is that the steam is expanded in *two stages.*

Types of Compound Engines

There are two distinct types of compound engine—the *tandem-compound,* and the *cross-compound.*

In the tandem-compound, the two cylinders are in line, the same as two horses when harnessed tandem. This arrangement is shown in the first figure on the blackboard. It is evident that this engine has but one crank, one connecting rod, and one piston rod, for both pistons are fastened on the same rod. This engine gives the advantage of a saving of steam an account of the compounding feature, but in all other respects it is like a single-cylinder engine.

The cross-compound, shown in the second figure, is practically two engines with cranks fastened to the same shaft, and the cylinders of different size. These cylinders are connected by a receiver, which is a reservoir or a large pipe; and the steam, after expanding in the small cylinder, is exhausted into the receiver. As the receiver connects with the admission valves of the low-pressure cylinder, the steam enters, and then completes the expansion. The receiver simply holds the steam until the low-pressure valves open.

This type has the advantage of compounding; and the two cranks, which are set at right angles to each other, exert a more constant turning moment on the shaft. One crank is giving its maximum force while the other is giving out less. This is of great advantage in cases requiring steady motion.

BLOWING OFF STEAM

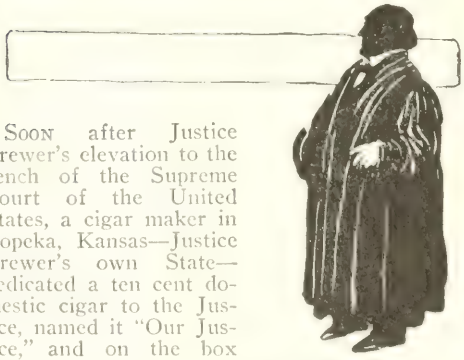
At George Washington's Tomb

THERE is a story of a gentleman who, upon visiting Mount Vernon, came across a lady kneeling before a building quite a distance from the Washington Monument. "Are you in trouble?" he asked her. "No, sir," she replied; "thank you very much. I am not in trouble, but my patriotic feelings overcome me when I gaze upon the tomb of the 'Father of his Country.'"

"I quite understand," he said, kindly; "but, madam, you have made a mistake. This is not the tomb of Washington; it is over yonder. This is the ice-house."

Quickly ceasing her weeping, the lady rose and moved away.

Justice Brewer's Claim to Fame



SOON after Justice Brewer's elevation to the bench of the Supreme Court of the United States, a cigar maker in Topeka, Kansas—Justice Brewer's own State—dedicated a ten cent domestic cigar to the Justice, named it "Our Justice," and on the box pasted a portrait of Justice Brewer.

A few years ago the Justice was in Topeka on a business trip. The hotel clerk recognized him; and the negro bell-boy, although he had no idea who the newcomer was, knew from the way he was ordered about that the patron was of some consequence. Going up in the elevator, the negro stared constantly at the tall, dignified man.

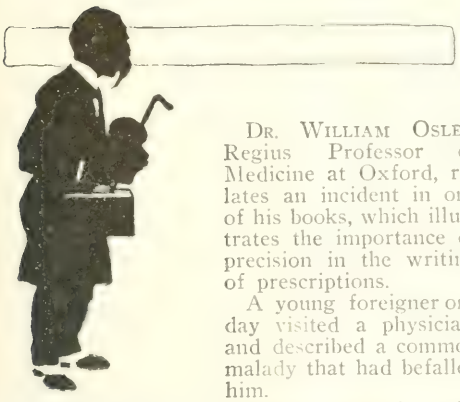
Suddenly the black face was wreathed in smiles, and the boy said:

"'Scuse me, Boss, but ain't you de gemmen dat invented dem 'Ouah Jestice' cigars?"

Senator Hoar on Profanity

SENATOR HOAR above all things disliked profanity. The story is told, how much shocked the venerable Senator would be by the inflammatory interjections of a certain politician with whom he frequently was compelled to confer. But on all such occasions he would refrain from censuring the culprit except in the mildest manner. One day when the politician came to the Senator's committee-room on a subject of considerable importance, Mr. Hoar indicated a seat to him, and remarked, "Now, Mr. Blank, before we enter upon a discussion of this question, we shall assume that everybody and everything is damned. Then we can talk it over amicably."

Dr. Osler's Prescription



Dr. William Osler, Regius Professor of Medicine at Oxford, relates an incident in one of his books, which illustrates the importance of precision in the writing of prescriptions.

A young foreigner one day visited a physician, and described a common malady that had befallen him.

"The thing for you to do," the physician said, "is to drink hot water an hour before breakfast every morning."

"Write it down, doctor, so I won't forget it," said the patient.

Accordingly the physician wrote the directions down—namely, that the young man was to drink hot water an hour before breakfast every morning. The patient took his leave, and in a week he returned.

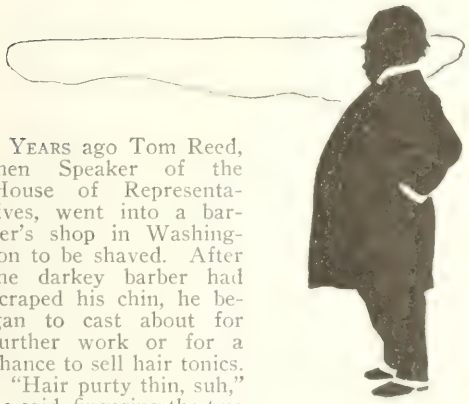
"Well, how are you feeling?" the physician asked.

"Worse, doctor; worse, if anything," was the reply.

"Ahem! Did you follow my advice and drink hot water an hour before breakfast?"

"I did my best, sir," said the young man, "but I couldn't keep it up mor'n ten minutes at a stretch."—*Tit-Bits.*

Tom Reed Proves His Title



Years ago Tom Reed, then Speaker of the House of Representatives, went into a barber's shop in Washington to be shaved. After the darkey barber had scraped his chin, he began to cast about for further work or for a chance to sell hair tonics.

"Hair purty thin, suh," he said, fingering the two or three stray locks that fringed Mr. Reed's bald pate. "Been that way long, suh?"

"I was born that way," replied Reed. "Afterward I enjoyed a brief period of hirsute efflorescence, but it did not endure."

The barber gasped and said no more. Later someone told him he had shaved the Speaker.

"Speakah!" he exclaimed. "Don't I know dat? I should say he was a speakah, sure 'nuf!"

Could Prove an Alibi

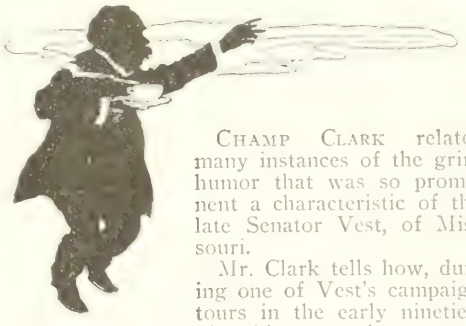
Sunday School Superintendent: "Who led the children of Israel into Canaan? Will one of the smaller boys answer?"

No reply.

Superintendent (somewhat sternly): "Can no one tell? Little boy on that seat next to the aisle—Who led the children of Israel into Canaan?"

Little Boy (badly frightened): "It wasn't me. I—I just moved yere last week f'm Mizzoury."

How Senator Vest Roasted the Coffee



Champ Clark relates many instances of the grim humor that was so prominent a characteristic of the late Senator Vest, of Missouri.

Mr. Clark tells how, during one of Vest's campaign tours in the early nineties, is was necessary for him to sojourn over night in the town of St. Charles. The best hostelry the place afforded was poor enough, and at breakfast Vest was especially put out by the stuff that was placed before him for coffee.

After having sampled the beverage, Vest with a frown called for the proprietor. When that individual had appeared, the Senator asked, with a wave of his hand toward the offending liquid smoking innocently before him:

"Sir, what is this stuff?"

"Coffee," meekly replied the proprietor, somewhat taken aback.

"Coffee!" repeated Vest, in fine scorn; "my friend, I could insert a coffee bean in my mouth, dive into the Missouri river, swim to the town of Alton, Ill., and I'll guarantee that one could bail up much better coffee than this, sir, over the entire route!"—*The Search-Light.*

Father Knew

"Pop."

"What is it, Johnny?"

"Why is the head of a bedstead always higher than the foot?"

"For the same reason that the rear wheels of a wagon are always bigger than the front ones, Johnny."

"Thanks, pop."—*Kansas City Times.*

Principles of Ventilation

Explaining the Composition of the Air, the Impurities it May Contain, and Giving Rules to be Followed for Insuring a Proper Supply of Fresh Air in Buildings

By ALFRED L. HUBBARD, S. B., M. E.

THE problem of maintaining air of a certain standard of purity in various buildings occupied, is one of supreme importance, and stands in very close relation to the problem of heating.

The introduction of pure air can be done properly only in connection with some system of heating; and no system of heating is complete without a supply of pure air, depending in amount upon the kind of building and the purpose for which it is used.

Composition of the Atmosphere

Atmospheric air is not a simple substance, but a mechanical mixture. Oxygen and nitrogen, the principal constituents, are present in very nearly the proportion of one part of oxygen to four parts of nitrogen by weight. Carbonic acid gas, the product of all combustion, exists in the proportion of 3 to 5 parts in 10,000 in the open country. The quantity of water present, in the form of vapor, varies greatly with the temperature, and the exposure of the air to open bodies of water. In addition to the above, there are generally present, in variable but exceedingly small quantities, ammonia, sulphuretted hydrogen, sulphuric, sulphurous, nitric, and nitrous acids, floating organic and inorganic matter, and local impurities. Air also contains ozone, which is a peculiarly active form of oxygen; and in 1895 a hitherto unknown and exceedingly inert constituent called "argon" was discovered.

Oxygen is one of the most important elements of the air, so far as both heating and ventilation are concerned. It is the active element in the chemical process of combustion, and also of a somewhat similar process which takes place in the respiration of human beings. Taken into the lungs, it acts upon the excess of carbon in the blood, and possibly upon other ingredients, forming chemical compounds which are thrown off in the act of respiration or breathing.

Nitrogen composes the principal bulk of the atmosphere. It exists uniformly diffused with oxygen and carbonic acid gas. This element is practically inert in all processes of combustion or respiration. It is not affected in composition, either by passing through a furnace during combustion or through the lungs in the process of respiration. Its action is to render the oxygen less active, and to absorb some part of the heat produced by the process of oxidation.

Carbonic acid gas is of itself only a neutral constituent of the atmosphere, like nitrogen; and, contrary to the general impression, its presence in moderately large quantities (if uncombined with other substances) is neither disagreeable nor especially harmful. Its presence in the air, however, provided for respiration, decreases the readiness with which the carbon of the blood unites with the oxygen of the air, and therefore, when present in sufficient quantity, may cause indirectly, not only serious, but fatal results. The real harm of a vitiated atmosphere is caused by its other constituent gases, and by the minute organisms which are produced in the process of respiration. It is known, however, that these other impurities exist in fixed proportion to the amount of carbonic acid present in an atmosphere vitiated by respiration. Therefore, as the relative proportion of carbonic acid may be easily determined by experiment, the fixing of a standard limit of the amount in which it may be allowed also limits the amounts of other impurities which are found in connection with it.

When carbonic acid is present in excess of 10 parts in 10,000 parts of air, a feeling of weariness and stuffiness, generally accompanied by a headache, will be experienced; while with even 8 parts in 10,000 parts a room would be considered close. For general considerations of ventilation, the limit should be placed at 6 to 7 parts in 10,000, thus allowing an increase of 2 to 3 parts over that present in outdoor air, which may be considered to contain four parts in 10,000 under ordinary conditions.

Analysis of Air

The amount of carbonic acid present in the air may be readily determined with sufficient accuracy for practical purposes, in the following manner:

Six clean, dry, and tightly corked bottles, containing respectively 100, 200, 250, 300, 350, and 400 cubic centimeters, a glass tube containing exactly 15 cubic centimeters to a given mark, and a bottle of perfectly clear, fresh limewater, make up the apparatus required. The bottles should be filled with the air to be examined by means of a hand-ball syringe. Add to the smallest bottle 15 cubic centimeters of the limewater, put in the cork and shake well. If the limewater has a milky appearance the amount of carbonic acid will be at least 16 parts in 10,000. If the contents of the bottle remain clear, treat the bottle of 200 cubic centimeters in the same manner; a milky appearance or turbidity in this would indicate 12 parts in 10,000. In a similar manner, turbidity in the 250 cubic centimeter bottle indicates 10 parts in 10,000; in the 300, 8 parts; in the 350, 7 parts; and in the 400, less than 6 parts. The ability to conduct more accurate analyses can be attained only by special study, and a knowledge of chemical properties and methods of investigation.

Air Required for Ventilation

The amount of air required to maintain the standard of purity can be very easily determined, provided we know the amount of carbonic acid given off in the process of respiration. It has been found by experiment that the average production of carbonic acid by an adult at rest is about .6 cubic foot per hour. If we assume the proportion of this gas as 4 parts in 10,000 in the external air, and are to allow 6 parts in 10,000 in an occupied room, the gain will be 2 parts in 10,000; or, in other words, there will be $\frac{2}{10,000} = .0002$ cubic foot of carbonic acid mixed with each cubic foot of fresh air entering the room.

Therefore, if one person gives off .6 cubic foot of carbonic acid per hour, it will require $.6 \div .0002 = 3{,}000$ cubic feet of air per person to keep the air in the room at the standard of purity assumed—that is, 6 parts of carbonic acid in 10,000 of air.

The following table has been computed in this manner, and shows the amount of air which must be introduced for each person in order to maintain various standards of purity:

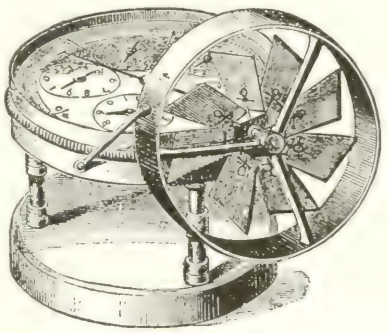


FIG. 1. AN ANEMOMETER.

Air Required for Ventilation

STANDARD PARTS OF CARBONIC ACID IN 10,000 OF AIR IN ROOM	CUBIC FEET OF AIR REQUIRED PER PERSON	
	PER MINUTE	PER HOUR
5	133	8,000
6	67	4,000
7	44	2,667
8	33	2,000
9	27	1,600
10	22	1,333
11	19	1,151
12	17	1,000

While this table gives the theoretical quantities of air required for different standards of purity, and may be used as a guide, it will be better in actual practice to use quantities which experience has shown to give good results in different types of buildings. Authorities differ somewhat in their recommendations on this point, and the present tendency is toward an increase of air.

The following table represents good

modern practice and may be used with satisfactory results:

Air Supply for Various Classes of Buildings

Air Required per Occupant in	Cubic Feet Per Minute	Cubic Feet Per Hour
Hospitals	50 to 80	3,000 to 4,000
High Schools	50	3,000
Grammar Schools	40	2,400
Theaters and Assembly Halls	25	1,500
Churches	20	1,200

Force for Moving Air

Air is moved for ventilating purposes in two ways—first, by expansion due to heating; and second by mechanical means. The effect of heat on the air is to increase its volume and therefore lessen its density or weight, so that it tends to rise and is replaced by the colder air below. The available force for moving air obtained in this way is very small, and is quite likely to be overcome by wind or external causes. It will be found in general that the heat used for producing velocity in this manner, when transformed into work in the steam engine, is greatly in excess of that required to produce the same effect by the use of a fan. Ventilation by mechanical means is performed either by pressure or suction. The former is used for delivering fresh air into a building, and the latter for removing the foul air from it. By both processes the air is moved without change in temperature, and the force for moving must be sufficient to overcome the effects of wind or changes in outside temperature. Some form of fan is used for this purpose.

Measurements of Velocity

The velocity of air in ventilating ducts and flues is measured directly by an instrument called an *anemometer*. The common form of this instrument is shown in Fig. 1. It consists of a series of flat vanes attached to an axis, and a series of dials. The revolution of the axis causes motion of the hands in proportion to the velocity of the air.

Air Distribution

The location of the air inlet to a room depends upon the size of the room and the purpose for which it is used. In the case of living rooms in dwelling-houses, the registers are placed either in the floor or in the wall near the floor; this brings the warm air in at the coldest part of the room, and gives an opportunity for warming or drying the feet if desired. In the case of schoolrooms, it is best to discharge air through openings in the wall at a height of 7 or 8 feet from the floor. This gives a more even distribution, as the warmer air tends to rise and hence spreads uniformly under the ceiling; it then gradually displaces other air and the room becomes filled with pure air without sensible currents or drafts. The cooler air sinks to the bottom of the room, and can be taken off through ventilating registers placed near the floor. The relative positions of the inlet and outlet are often governed to some extent by the building construction; but, if possible, they should both be located in the same side of the room. Figs. 2, 3, and 4 show common arrangements.

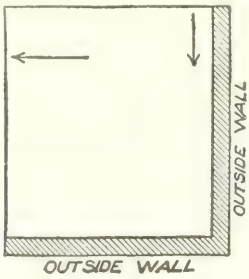


Fig. 2.

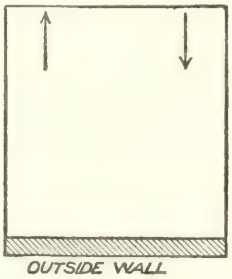


Fig. 3.

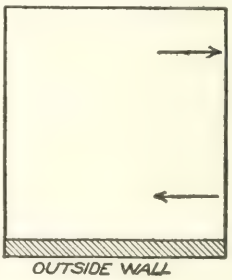


Fig. 4.

The vent outlet should always, if possible, be placed in an inside wall, else it will become chilled and the air-flow through it will become sluggish. In theaters or halls which are closely packed, the air should enter at or near the floor, in finely-divided streams, and the discharge ventilation should be through openings in the ceiling.

Invitation to Readers

THE TECHNICAL WORLD MAGAZINE is published for the information, as well as for the entertainment, of its readers. Primarily its purpose is to be helpful, rather than merely interesting.

Are you puzzled by any question in engineering or the mechanic arts? State your problem in writing, and mail it to the Consulting Department of THE TECHNICAL WORLD MAGAZINE. It will be answered as speedily as possible by an expert especially familiar with the questions involved. For the purpose of having the work done thoroughly and in an authoritative way, THE TECHNICAL WORLD MAGAZINE has made arrangements with the American School of Correspondence to have all problems of a technical nature submitted by its readers answered by the members of the school's staff of professors. Requests for information as to where desired articles can be purchased, will be cheerfully answered.

If the question asked or the problem presented is of general interest, the solution will be printed in the columns of the magazine. If of merely personal interest, it will be forwarded by mail, provided an addressed and stamped envelope is enclosed for the purpose, when the question is sent in.

Drawing Electricity from Atmosphere

Question: Would it add to the efficiency of a dynamo to have wire conductors connecting with the dynamo and leading out into the open air in different directions? Since everything contains its own normal amount of electricity, if the dynamo should draw the electricity from the conductors, would nature keep up the supply?—*W. D. A.*

Answer: The scheme you suggest is entirely impracticable, and you could not increase the efficiency of a dynamo in the least in this manner.

Boiler Pulsation

Question: What is the cause of boiler throbbing and what is to be done to stop it?—*R. V. W.*

Answer: Pulsation in steam boilers is induced sometimes by weakness and want of capacity in the boiler to supply the necessary quantity of steam, and sometimes by the boiler being badly designed, thereby admitting of a great disproportion between the heating surface and steam room. In factories, boilers are frequently found that were originally of not more than sufficient capacity to furnish the necessary quantity of steam; but, as business increased, it became necessary to increase the pressure and also the speed of the engine, or, perhaps, to replace it with a larger one, which had to be supplied with steam from the same boiler. The result in such case is that each time the valve opens to admit steam to the cylinder, about one-third of the whole quantity in the boiler is admitted, thus lowering the pressure; the next instant, under the influence of hard firing, or, perhaps, a forced draught, the steam is brought to the former pressure; and

so on. This alternate lessening and increasing the pressure continues while the engine is in motion, and has an effect on the boiler similar to the breathing of an animal.

The strains induced by this pulsation are transmitted to the weakest places—namely, the lines of the rivet-holes, and those marked by the tool in the process of calking, the result being that in time the plate is broken in two. The manner in which the fracture takes place may be illustrated by filing a small nick, or drilling a small hole, in a piece of hoop or band iron, and then bending back and forth, when it will be discovered that the material will break just at that point, however slight the nick or small the hole may be.

Pulsation is frequently very severe in the boilers of tugboats when commencing to start a heavy tow, and also in locomotives when starting long trains. Some frightful explosions of the boilers of tugboats and locomotives have occurred under such circumstances. Pulsation, if permitted to continue, is sure to effect the destruction of the boiler. It is always made manifest by the vibration of the pointers on steam gauges, or an unsteadiness in the mercury column. It may be remedied, to a certain extent, by adding a larger steam dome; but this has a tendency to weaken the boiler and render it more unsafe. The only sure preventive of such a silent and destructive agent is to have the boiler of sufficient capacity in the first place.

To Find Horse-Power of Alternator

Question 1: How can I find the horse-power of a three-phase alternating current at 25 cycles, having the volts and amperes given?

Question 2: Can an alternator of 25 cycles and 400 volts be used for 110-volt incandescent lights; and if so, how?—*J. E. S.*

Answer 1: The horse-power can be found by multiplying the voltage and current together, and their product by $\sqrt{3}$. Then multiply this by the power factor, and divide by 746.

Answer 2: An alternator of 25 cycles and 400 volts could be used to supply 110-volt lamps only by stepping down the voltage to 110 by means of the proper transformer. Four of these 110-volt lights might be put in series across the 400-volt circuit, but they would not burn at anything like their full brilliancy, because of the fact that they would be getting only 100 volts each instead of 110 volts as they ought to do.

The Paul System

Question: What is the "Paul" system?" Please describe it and give advantages.—*A. T. M.*

Answer: It is a system of vacuum heating applied directly to the radiators or points of distribution. It is a method of exhausting air only, the air-pipes being connected at a point above the water line. The installation of the system is very simple. One-fourth-inch pipes are used for connecting to the air-valves on each radiator or coil. The air-valves operate on the thermostatic principle, and are easily adjusted for ordinary conditions. The risers and mains are run parallel to the steam supply pipes, the risers in no case being more than one-half inch in diameter, the main into which they connect being three-fourths inch for buildings of the largest size.

The "Paul" system is used in connection with a gravity heating plant. No attempt is made to handle the water of condensation, which is allowed to return by gravity to the receiving tank or boiler. To one familiar with the ordinary gravity system, the manner in which this is accomplished is readily understood.

The exhausting apparatus for developing vacuum may be operated by any source of power; but in large plants having high-pressure steam a steam exhauster or ejector is preferable. The amount of steam used for operating the exhauster is so small that it need not be considered. A system having 20,000 square feet of radiation may be operated constantly at or below atmospheric pressure, with a steam consumption of not more than 20 to 25 pounds per hour.

If the best results are to be obtained, the air-pipe system must be installed in such a manner that there shall be absolutely no leakage of air. It is also desirable to have the entire heating system tight; for if any portion is leaky or in bad condition, a high degree of vacuum will

be impossible. The air-pipe system should be so installed as to stand a pressure of 40 pounds per square inch for a period of two hours without material drop.

The principal advantages of the "Paul" system are: First, economy of operation. Every engineer understands the value of exhaust steam for heating purposes; but the great difficulty has always been the circulation of exhaust steam without back pressure on the engines. With the "Paul" system, all back pressure is removed; and the exhaust steam, circulating freely through the heating system, becomes a source of great revenue, and adds greatly to the economy of the plant.

A heating plant equipped with the "Paul" system has no open valves to cause trouble by leakage or by offensive odors. The air-pipes being connected with the air-valves, the system is entirely sealed; and a vacuum being maintained, there is no pressure, and steam or water cannot escape.

Alternating Current from a Medical Battery

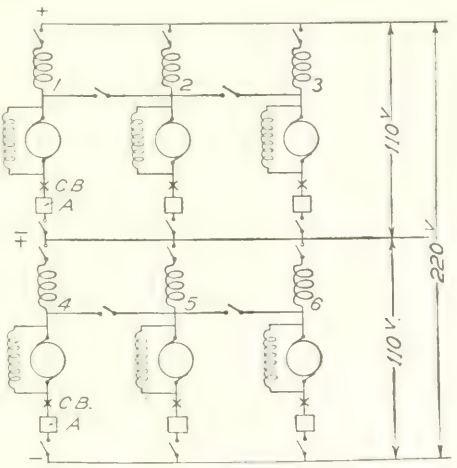
Question: I have a medical battery from which a powerful shock may be obtained, and the electricity is obtained from one small dry cell. The induction coil consists of one coil of wire wound over another. The inner coil is connected to the dry battery, and the circuit is made and broken by a vibrator. Will you please tell me whether the current obtained from the terminals of the outside coil is direct, alternating, or pulsating? Also what is a Faradic current?—*J. S. C.*

Answer: The current induced in the secondary of an induction coil is alternating in its nature. When the circuit is closed in the primary, a magnetic field is set up by the primary current, the lines of which cut the turns in the secondary coil. This induces a secondary electromotive force in one direction. When the primary circuit is broken, this magnetic field collapses and cuts the secondary conductors in the opposite direction, thus producing an electromotive force in the opposite sense. You will thus see that the secondary electromotive force and the secondary induced current must be alternating.

In regard to the Faradic current, would say that this term is very seldom used. It has been defined, however, as a rapidly alternating current, as opposed to a uniform direct current. It is sometimes used in therapeutics to indicate the high-potential current obtained from the secondary of the induction coil.

Grouping of Generators

Question: I am at present engaged in a private plant using 220 volts for power and lighting. I would like to know the best way of connecting up three units consisting of two 110-volt machines in series.—*P. A. S.*



Connections of Generators.

Answer: The accompanying sketch will show you the proper method of connecting these machines. You might consider that you had two units, each consisting of three compound-wound machines in parallel, and the two units connected in series on the three-wire system. Or, you might consider that you had three pairs of machines on the three-wire system, these three pairs being connected in parallel. An equalizer should, of course, be used to connect together the brushes as shown at *1, 2, 3,* and *4, 5, 6.* The circuit-breaker *C. B.* and ammeter *A* should be on the opposite side from the series coil.

SCIENCE AND INVENTION

Telemobiloscope

COLLISIONS between ships are not the least among the perils of the deep. Any device which will effectively reduce the risk of such disaster, is a veritable boon to mankind. Such a device, named the "Telemobiloscope," has recently been invented and patented by Christian Hülsmeyer, an engineer of Düsseldorf, Germany, who utilizes the action of Hertzian waves, such as are used in wireless telegraphy. The device—which can be installed on railway trains as well as on ships—combines both a sending and a receiving apparatus. The electric waves, striking a distant metallic object—such as a ship—are reflected back to the receiver, there operating to signal the approach of said object, as well as to indicate, by special mechanism, its direction and distance.

As ships are subject to oscillation, and the range of the receiver is limited, the apparatus is suspended after the manner of a ship's compass, thus maintaining a practically constant position in relation to the horizon (Fig. 2). In the hollow hemisphere *c* is an induction coil *d*, operating the sender, and deriving its primary current from some source of energy (storage battery or dynamo) on the vessel. The high-tension secondary current passes through collector rings and sliding brushes to the oscillator *h*. The waves issuing from the latter are projected with a given inclination from the projection-box *l* and the concave mirror *m* placed inside. At *o* (Fig. 2), suspended in front of a concave screen *n* (shown in plan in Fig. 4), are the *antennæ* or receiving wires, which pick up the reflected waves. These may be located in any part of the rigging, but must be well insulated from the sending apparatus. The *antennæ* are connected with a coherer of the type common in wireless installations, which serves to operate the audible or visible signal.

The apparatus is made to rotate intermittently by means of driving gear around the wheel *q*. In this way the waves given off by the oscillator search, as it were, a greater or less range round the observing station, for metallic objects susceptible of reflecting the waves and thus actuating the coherer. As the concave screen *n* follows the rotation, its position serves to indicate the direction from which come the reflected waves, and thus the direction in which the distant object lies.

The complete apparatus includes a special device furnishing data—based on the inclination of the vertical axis of the system to the plane of the horizon—from

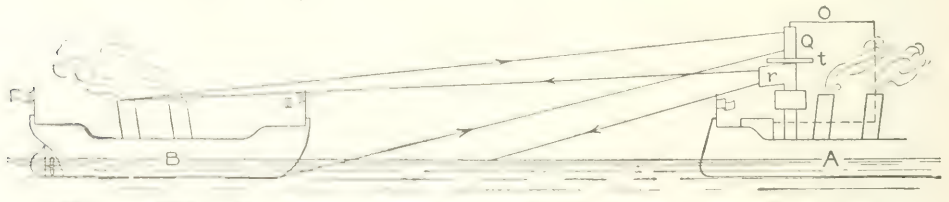


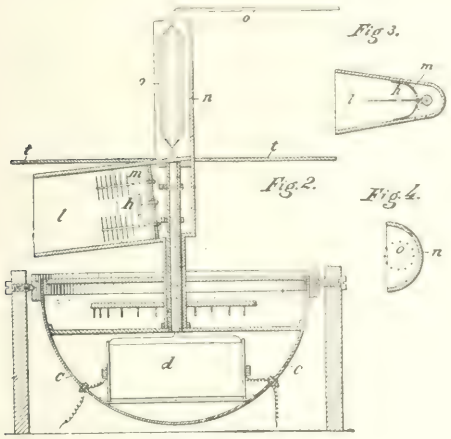
FIG. 1. APPROACH OF ONE VESSEL (*B*) DETECTED BY INSTRUMENT INSTALLED ON ANOTHER VESSEL (*A*).

which the distance of the reflecting object is known.

The apparatus represented in Fig. 2 is shown installed on the foredeck of the vessel *A* in Fig. 1. The electrical waves issuing from the sender *r* strike the vessel *B*, and, after being reflected, strike the antennæ *o* by which the receiver at the observer's station is operated.

Tests conducted under auspices of the Government of the Netherlands in the Harbor of Rotterdam, have given proofs of the efficiency of the invention. An accurate reflection was insured up to a distance of nearly two miles, with sending apparatus including four condensers of .00188 microfarad, the outer armatures of which were connected. The antennæ were a little over 16 feet long, suspended from a bamboo rod. By combining the receiving antennæ with the reeling, the inventor hopes to extend the range to nearly twenty miles.

The apparatus is also to be tested by the French and Italian Governments.



DETAILS OF TELEMOBILOSCOPE.

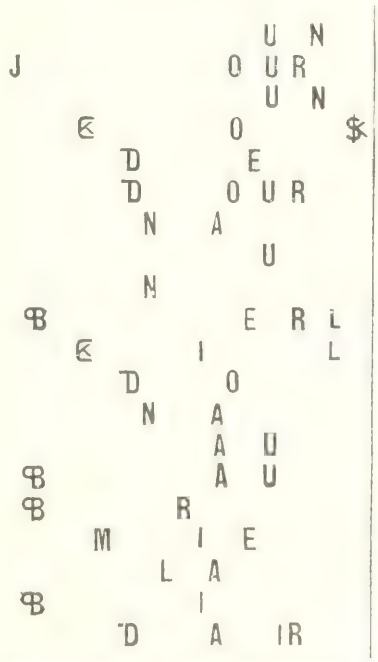
A Stenotyping Machine

A VERY efficient stenotyping machine by which a syllable (and in some cases two or three syllables) is printed in plain type at each stroke of the fingers, has just been invented by M. Bivort of Paris. This result has been obtained by an ingenious arrangement of the letters of the alphabet, and by combining certain letters representing similar sounds—such, for instance, as D and T.

USING THE NEW SHORTHAND TYPEWRITER.

It is said that fifty words per minute can be written after a few days' training, while a normal speed of 125 to 150 words is obtained in less than two months, and speeds of 200 words and more are in no way unusual.

The necessity of designing a shorthand-writing machine to supplement the typewriter, has been felt for a long time, but it is only within recent years that a more or less successful machine has been constructed. Any one of the existing manual shorthand-writing systems is



MESSAGE WRITTEN [illegible] NEW SHORTHAND TYPEWRITER.
[illegible]

known to be liable to misinterpretation, especially by a third person, while a desirable speed is attained only by the most efficient writers and only after arduous training.

The "Sténophile" represented in the accompanying photograph will no doubt soon be adopted in every field of trade and industry, and before long become an indispensable adjunct of the typewriter, its most valuable feature being that no conventional signs, but plain types, are employed.—Dr. Alfred Gradenwitz.

Fireless Stoves

EXPERIMENTS which are being made with the so-called fireless cook-stove at several army posts in this country, indicate that this novel idea is of considerable value. Among those who are making tests with the view of determining its importance in connection with the United States Commissary, is Captain M. S. Murray at Rort Riley, Kansas. Captain Murray completed the

Fireless Cook-Stove.

cooking of several different kinds of food with the use of the "hay box," and states that the results in general were very successful. A half-pound of rice, an equal quantity of hominy, and a pound of beans were placed in cans and exposed to the fire, being allowed to boil five minutes. They were then taken out, placed immediately in the hay-box, and examined one hour and fifteen minutes later. The rice was thoroughly cooked, but the hominy and beans were only partly done. A stew made of beef, potatoes, and onions was prepared, placed over the fire until it had boiled six minutes, then placed in the hay-box. At the end of two hours it was found to be thoroughly cooked, and was served at the table. Captain Murray also took equal parts of macaroni and tomatoes, placed them in a tin can, and, after allowing them to boil five minutes, packed them in the receptacle. When examined at the end of seventy minutes, they were found to be perfectly cooked. Beans and bacon were allowed to boil six minutes, and were ready for the table in two hours.

It was the opinion of those who ate the viands thus prepared, that each dish was not only as palatable as if prepared entirely on a stove or in the oven, and in some cases more palatable. As a result, Captain Murray has designed a special "fireless stove" for use in the field, which is shown in the accompanying illustration. It consists merely of a wooden chest having a cover with edges which overlap the top of the box. The chest is lined with thick cloth and filled with straw or hay. When the dishes are set in the box to complete the cooking, the hay is carefully packed around the sides of each dish and near the tops. Then a piece of heavy flannel or wadded cloth is laid over the hay, and the lid battened down.

Welding by Acetylene

AN Italian engineer has recently developed a very efficient and economic process for welding steel and iron by means of acetylene gas. The heat produced by the combustion of acetylene and oxygen mixed at the moment of burning, is about 7,200 degrees F., which is higher than the temperature of the oxyhydrogen flame and near that of the electric arc. The process is applicable to the welding of metals and parts not amenable to the usual methods. The requisite heat for welding, it is claimed, can be obtained by the new process in a short time.

Elevated Railway Levels

OBSERVERS at the various stations along the line of the elevated railroad in Chicago, noticing that the tracks slope gently downward on either side from the stations, have jumped at the conclusion that the purpose of this construction has been to take advantage of the action of gravity in controlling the movement of trains. This, however, is a misconception. The net reduction in operative cost through such means would be but very slight, if anything. The reason for the lower level between stations is found in the fact that this was the original construction level, and when the city ordered a higher elevation at the stations, the company found it cheaper to leave the track at its old level in parts than to raise it uniformly to the new elevation required at the stations.

A Dog Cemetery

THERE is a cemetery in London where all the epitaphs that are written on the tombstones are true. Of course it is not a cemetery for human beings, for when these die, no matter how base the lives they have lived, the inscriptions on their tombs usually have a tone of euphemistic eulogy. This is a dogs' cemetery. It is located in a little, secluded spot, right in the heart of the great city. People, even strangers, when they read these epitaphs, often shed tears, for they know that they are true. Marble never marks the resting place of a dog that was not worthy of all that is written about him. Here are some of the inscriptions one may read:

"She brought the sunshine into our lives, but took it away with her.

To our gentle, lovely little Blenheim—Jane."

"Dear old Topsy, for over sixteen years the faithful friend of Sir —— and his family—Loved, lamented, and respected."

"There are men both good and wise, who say that dumb creatures we have cherished here below shall give us kindly greeting when we have passed the Golden Gate."

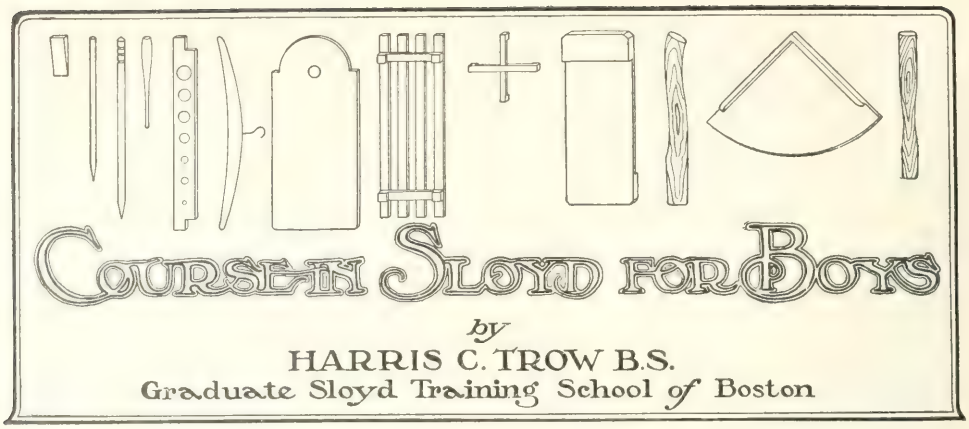
"Our Robin—Only good night, dear one!—She talked with soft brown eyes more eloquent than speech."

CEMETERY FOR DOGS, HYDE PARK, LONDON.

And there are hundreds of other heartfelt expressions of tender sentiment. Nothing there is conventional. The reader knows they are genuine.

Multum in Parvo

TO put a quart of water into a pint bottle is a physical impossibility in the nature of things. But to combine in a single instrument a maximum of convenient uses in a minimum of space, is no uncommon achievement of modern ingenuity. We have, for example, "pocket handbooks" that surpass the whole Bodleian Library in practical value as works of reference; we have "pocket tool-chests" that are not only the delight of the small boy but frequently the relief of the family in emergency. And now we have, as a result of the pecuniary necessities that had beset one correspondence school student, a new drafting instrument to which has been given the appropriate name of the "Ready." It combines an amazing multiplicity of time- and labor-saving features in a device of pocket size and small cost. It serves all the uses of the T-square, compass, scale, and protractor. By its means, angles of any degree can be readily determined or drawn, diameters found in 16ths of an inch, delay of adjusting compass points to centers avoided, etc. By a convenient system of observation openings, the progress of any arc being drawn can be "kept in sight."



Fifth Lesson—Model No. V. Flower-Pot Stand

A PERSPECTIVE view of this model is shown in Fig. 1, and the complete working drawing with dimensions is shown in Fig. 2. The new tools required are a hammer A. E., B. F., price 42 cents; and a nail set, hollow point, price 10 cents. The initials A. E., B. F. as used above, represent the words Adz Eye, Bell Face. The stock should be white pine of ¾-inch thickness.

As seen in Figs. 1 and 2, the stand consists of two supports or standards, upon which are nailed four cross-pieces, making in all six separate parts.

Let us begin with the standards first. It would perhaps be quite natural to get out two separate pieces of stock for these two parts, but it can readily be seen that it is simpler to work them as far as possible in one piece, but of twice the length. Accordingly a piece of stock should be roughed out with the splitting saw and the crosscut saw, about 10½ inches long by 1¼ inches wide. One of the broader surfaces should be planed straight and true with the jack-plane for the working surface. Then finish one of the narrow surfaces at right angles to this, using the eye to test both its straightness and squareness as far as possible. The try square should also be used to check the accuracy of the eye as to squareness. When this surface has been properly finished, gauge the width of 1⅛ inches with the marking gauge, and finish the other narrow surface straight and square with the working surface. Now gauge the width ⅝ inch on both narrow surfaces, and finish to the gauge marks. When this has been done, block-plane one end in the bench hook and cut off to length 5⅛ inches, allowing enough to finish the other end with the block-plane. In a similar manner block-plane and finish the second piece to the exact length required.

Next lay off a distance of ¾ inch from each end on one of the narrow surfaces of one of these pieces for the shoulders, as shown at A and B, Fig. 2. Lay off these shoulders with the try-square and pencil, marking the lines over with the point of the Sloyd knife guided by the try-square. Gauge a line on both of the broader surfaces between A and B, 5-16 inch from the edge. The cross-cuts should be made with the back saw exactly to a depth of 5-16 inch. Then remove the stock between them, down *to* the gauge line, with the Sloyd knife. Fin-

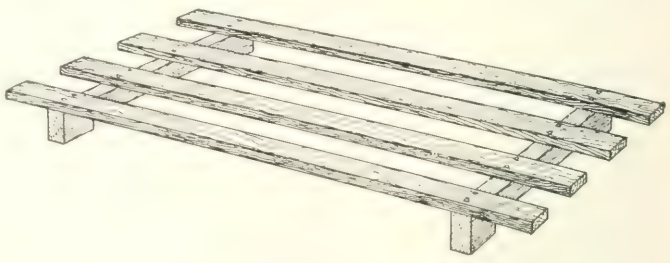


Fig. 1. Perspective View of Model.

ish the second piece in like manner, smoothing with sandpaper and block. Remember to remove only the smallest possible amount of stock in the process and keep all corners square.

The four cross-pieces should be worked in one piece as far as possible, but not from stock four times the length of one piece, as this would be too long to work to advantage. For making these cross-pieces, block out a piece of the ¾-inch stock a little over 15 inches long and wide enough to make four pieces of 5-16 inch thickness each, allowing for finish. A width of 1¾ inches should be sufficient. This should be planed along one of its broader surfaces straight and true, and a narrow surface should be planed at right angles to this. A shaving should also be taken off the other narrow surface, although the stock need not of course be finished to any definite width at this stage. Now gauge the thickness of ⅝ inch and plane to the gauge marks. Next block-plane one end of the piece in the bench hook, lay off the length, and block-plane the other end. The thickness of the stock is now exactly equal to the width of the cross-pieces. From the finished narrow surface, gauge lines 5-16 inch from it on both the broader surfaces, lengthwise of the piece. Then with the splitting saw cut off the strip thus blocked out, allowing enough stock to finish it to a thickness of 5-16 inch with the jack-plane. When this cut has been made, one of our strips will be complete.

The cut with the splitting saw will have left the narrow surface of our original piece of stock rough and somewhat uneven, and this should be trued up with the jack-plane. A second strip can now be cut out as before, and the third and fourth in a similar manner. After smoothing these strips with sandpaper and block, all the parts of the stand are ready to be assembled. The four strips should be laid side by side on their broader surfaces on the bench, and a distance of 1¾ inches laid off from each end to locate the position of the supports. A line should then be drawn lightly across. As seen in the illustrations, the outer strips are flush with the ends of the supports. Beginning with one of the outer strips placed in this position, with the supports 1¾ inches from its ends, and perfectly square with it, secure in position by nailing with ⅞-inch brads. Next place the other outer strip in position and nail in place. The third and fourth strips can then be nailed on in the position indicated by the dimensions in Fig. 2. The heads of the nails should be sunk slightly below the surface by means of the nail set. In driving these nails the work should be supported firmly, immediately under the spot into which the nails are being driven, otherwise the work will spring.

A final touch of the sandpaper in connection with the block, will complete the work, and a useful and ornamental model will be the result if directions as given in connection with previous lessons have been properly followed.

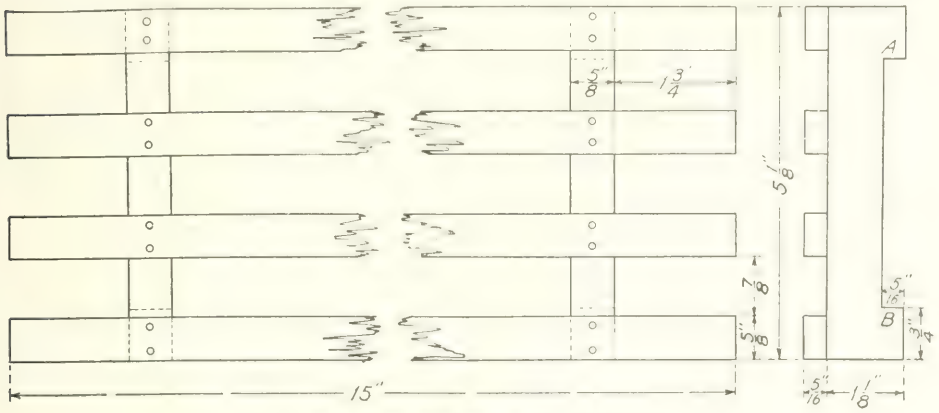
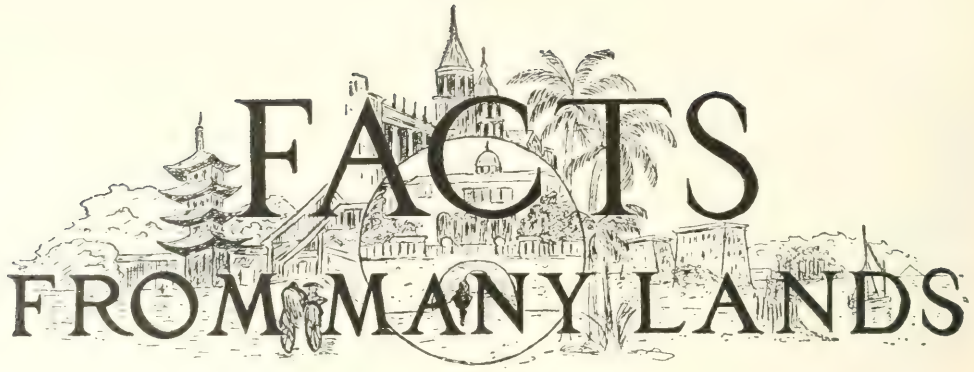
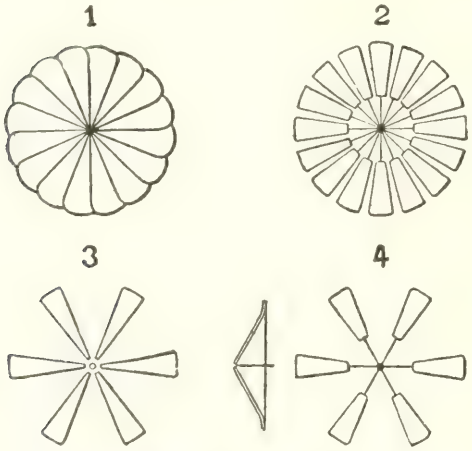


FIG. 2. COMPLETE WORKING DRAWING.



SOURENSEN, the Danish builder of windmills, recently discovered, through an accident, a form of windmill which tests show to develop more power than any other form heretofore tested. He had been running an old mill bearing ten wooden vanes. In a storm, four of these vanes were carried away, when, to the wonder of its proprietor, the old mill worked better than before. Inspired by this demonstration, he made some further experiments, and perfected a wind motor of conical form, having six vanes, the ends of which curved toward the summit of the cone. Prof. P. LaCour, who has established, by authority of the Danish Government, an observatory for the study of wind power, showed that the new conical aëromotor developed more power by nearly five per cent than that of the "Ventocrat" type, whose surface is seven times as great; and thirty-one per cent more than the "Rose of the Winds" type, with a surface three times as great; and twenty-nine per cent more than that of the old Sourensen type. It is predicted that the discovery of this new form of wind engine will go far towards making wind power, which is now largely lost, available for general use.

The Best Form of Windmill



VARIOUS TYPES OF WINDMILL.
1—Ventocrat. 2—Rose of the Winds. 3—Sourensen. 4—New Conical.

PAWNBROKERS in China are the bankers of the people and could not be dispensed with. The poor Chinaman, unlike the poor European, does not wear his winter clothes until they are fit only to be discarded. When the Chinise officials order that summer clothing shall be donned, the poor Chinaman pawns his winter suit; and with the proceeds, supplemented by a little cash, he redeems his previous summer garb or buys new attire. "Pawnbroking," writes Mr. Cunningham, in the *Chinese Soldier*, "is to the respectable Chinaman of limited means a weekly round."

Pawnbrokers in China

THE bogs of Maine are as full of peat as are the glens of Scotland. The Boston & Maine Railroad has been experimenting with peat-burning on locomotives, and so far the tests have given much satisfaction, the steaming qualities of the fuel being of the highest. The peats are subjected to heavy pressure, which exudes all the moisture, and, in

Firing Engines with Peat

pressing, are forced into an elliptical shape with an inch hole running through them, which admits of free burning. The fuel is entirely free from smoke.

Supplies for Panama Canal

THE purchases of the Panama Canal Commission include guinea pigs, white mice, wooden legs, Bibles, and playing cards. It has ordered 640,000 pounds of blasting powder and 675,000 pounds of dynamite. The paving of the city of Panama required 7,000,000 paving brick. Also 3,500,000 brick for the construction of buildings, with 30,000,000 feet of lumber, have been sent on. In addition to the locomotives in use by the railroad, 120 have been bought for excavating, together with 1,300 flat cars and hundreds of dump cars, 5,000 tons of steel rails, and 125,000 cross-ties upon which to lay the rails.

Power from Artesian Wells

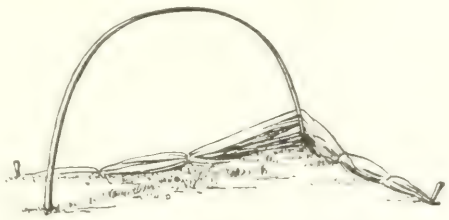
AN interesting source of power is found at Pierre, South Dakota, where the city has decided to put in an incandescent electric light plant to be driven by waste water from the artesian wells. Tests have shown that water, coming under pressure, will develop more than enough power to operate such a plant.

An Auto Rigged for Hoisting

A. A. STOLTZENBURG, of St. Louis, Mo., is using his automobile in an ingenious way. On week days it is rigged as a hoisting machine. When he goes out to do a job, Mr. Stoltzenburg loads tackle and windlass on the car, and it will carry the load to any part of the city, under its own power. The windlass attachment is carried on a special frame, which is firmly clasped to the rear axle, and driven by the sprocket chain, which, for the time being, is removed from the driving sprocket of the car. The rig is used chiefly for installing elevators. It has lifted 500 pounds to a height of 100 feet in forty minutes. In two hours with this improvised auto-hoister, one man can do the same amount of work that, under the old method of hoisting, it would take six men about six days to accomplish. On Sundays, Mr. Stoltzenburg removes the hoisting tackle from his car, puts in the regular body, and takes his family and friends for an outing through the parks.

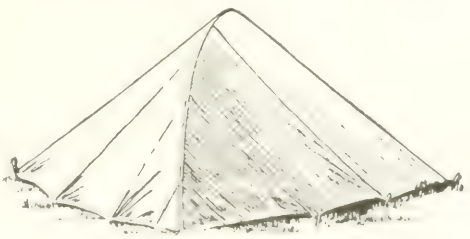
New and Easily Portable Tent

F. H. GOTCHE, of San Francisco, Cal., has recently patented a new tent which seems to combine many desirable features. As shown in the illustration, the frame of the tent is made up of four wooden sections, which



FRAME UP AND COVER READY TO STRETCH.

are held together by metal couplings. When ready to pitch the tent, the frame is bent into a semicircle, and the ends driven about six inches into the ground, the distance between them being twice as many feet as the tent is high. The cover is then pegged down on one side,



TENT READY FOR OCCUPANCY.

and tightly drawn over the frame, being so shaped that it will be completely supported and at the same time will stand a very severe gale without being blown down.

Carnegie Car of Gold

THE famous pay-car of the great Carnegie steel and iron interests makes its trips every fortnight, carrying its paymaster and his eight assistants over a route of about seventy-five miles of rail-

way, from Donora, Pa., to Youngstown, Ohio, paying out in that time upward of $2,000,000, nearly all in gold coin. A well-known authority at Homestead, who is in close touch with the mill hands, says of present conditions as compared with former years: "The boys never made so much money, nor have they been so prosperous as now. The increased tonnage and new machinery have made it possible for them to make more money than ever before. Everybody is happy and all is well."

Farm for College Boys

SCIENTIFIC training in agriculture will hereafter be a branch of instruction at the University of Chicago. The most modern methods in growing food products will be illustrated on the university farm near Wheeling, Ill., where 500 acres have been leased by the authorities of the university with an option of purchase. Here practical ideas in farming will be given each summer to a colony composed of students, professors, children of the latter, and pupils of Chicago high schools.

Mirror Serves as Lighthouse

THE most extraordinary of all British lighthouses is to be found on Arnish Rock, Stornoway Bay—a rock which is separated from the island of Lewis by a channel over 500 feet wide. On this rock a conical beacon is erected, and on its summit a lantern is fixed, from which, night after night, shines a light which is seen by the fishermen far and wide. The way in which this lighthouse is illuminated is this: On the island of Lewis is a lighthouse, and from a window in the tower a stream of light is projected onto a mirror in the lantern on the summit of Arnish Rock.

Laziest of all Workmen

THE Chinese coolies employed as laborers in building railroads in the Far East are as a rule listless and lazy. One method of escaping muscular effort in handling a shovel in track grading that seems to be very popular, is a chain attachment to the shovel handle near the blade. One coolie raises the shovel and drops it into the gravel or dirt while another at the end of the chain pulls forward the shovel blade, usually only partially filled with earth, to the desired place. This device for lazy workmen appears to be a recognized feature of the prevailing method of railroad construction. It constituted, in fact, a toy hand-scraper.

Tying Down the Desert

OVER 150,000 acres of sand dunes in France, once blown about by the wind until they overwhelmed great stretches of fertile ground and even threatened to bury whole towns, are now covered with forests of pine, which produce turpentine, lumber, and charcoal.

Thermometer Worth $10,000

THE most expensive thermometer in the United States is in use at the Johns Hopkins University, Baltimore, Md. It is valued at $10,000 and is an absolutely perfect instrument. The graduations on the glass are so fine that it requires a microscope to read them.

Teaching Pronunciation by Machinery

TWO ingenious Frenchmen have recently perfected several mechanical devices which are used in teaching French pronunciation to foreigners. One of them is a small instrument called a "larnyx-signal," which is held to the side of the throat when the diphthong "ou" is being pronounced. If the pupil is successful in getting the correct French pronunciation, a small bell attached to the larnyx-signal will notify him of his success by ringing. If the bell is silent, he may know that he has not given the word the correct pronunciation. Other machines are used for getting the correct pronunciation of various vowel sounds.

THE little town of Mount Carroll, Ill., boasts of a jail which is a terror to evil doers on account of its location. The town authorities took advantage of a high bluff on the edge of a stream which flows through Mount Carroll, to erect the building on its very edge. One-half of the structure—the part on the side toward town—is used by a fire company, but is entirely separated from the prison portion by a thick wall. The prisoners are confined in the part which overlooks the river. This section is supported on high wooden posts set into the side of the bluff, and the cells are over 100 feet above the water course. In fact they are so situated that to attempt to escape would undoubtedly mean certain death. Thus the jail is so protected by its natural location that there is no necessity of maintaining a guard, and the prisoners are unattended except at meal time and at other hours when the presence of some official is necessary.

A Self-Guarded Prison

ARMOUR & COMPANY of Chicago have arranged with the inventors of a liquid-air producing process to erect a small experimental plant in Chicago for the purpose of testing the value of liquid air for the refrigerating of perishable goods in refrigerator cars. It is claimed by the inventors that liquid air can be made in quantities at a cost of about one cent per gallon, and that it can be kept in refrigerator cars for a period of approximately thirty days, with an evaporation of not over three per cent per day unless it is forced. The result of these experiments is looked forward to with great interest.

To Cool Refrigerator Cars with Liquid Air

A NOVEL type of motor boat has been designed in France for the International Cup races. The hull is an absolutely flat bottom, 8 feet wide amidships; and the propeller shaft will be altogether exterior to the hull, having its extremities encased in bearings supported by brackets projecting from the keel. At the forward end of the shaft will be an enclosed chain wheel connected by a chain with the motor shaft above. A large De Dietrich engine will be employed to drive the boat. It is claimed by the designers that the novel shape of the hull will almost eliminate the speed-reducing factor known as skin-friction, for the vessel will merely glide over the water, the propeller shaft and the greater part of the rudder alone being immersed.

Novel Motor Boat

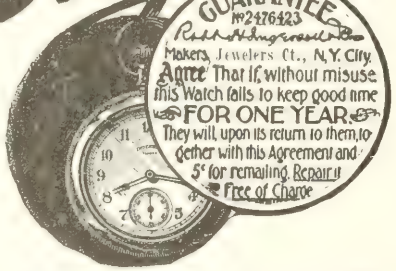
THE teaching of parrots to talk has occupied the attention of bird enthusiasts for many years, but it has remained for one Mrs. Hope of Philadelphia to utilize a modern invention to relieve the weary tedium of teaching Polly.

The parrot learns by sound, not by the sense of what it hears, and it is only by machine-like repetition of the sentence that Polly can be made to talk. Mrs. Hope has done away with the necessity for this drudgery by placing a phonograph close to Polly's perch, and, by keeping the talking-machine repeating for hours at a time the sentence which the parrot is to learn, she accomplishes the best and quickest results. In this way the parrot will learn a sentence in a week, while to become proficient in a number of sentences requires about six months. Those who have attempted the almost insurmountable obstacle of teaching Polly a number of sentences, will at once recognize the practical efficiency of the talking machine as a teacher.

Teaching Parrots by Phonograph

POLLY LEARNING FROM THE PHONOGRAPH.

Ingersoll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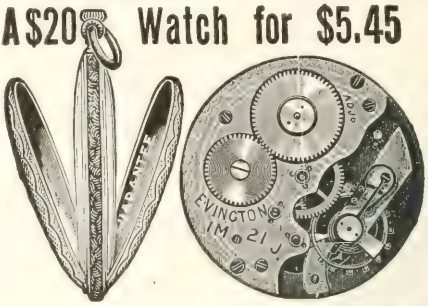

These figures tell exactly what we are doing—selling a $20.00 watch for $5.45. We don't claim that this is a $40.00 watch or a $50.00 watch, but it is a $20.00 watch. A leading watch manufacturer, being hard pressed for ready cash, recently sold us 100,000 watches—watches actually built to retail at $20.00. There is no doubt that we could wholesale them to dealers for $12.00 or $13.00, but this would involve a great amount of labor, time and expense. In the end our profit would be little more than it is at selling the watch direct to the consumer at $5.45. The Evington Watch, which we offer at $5.45 is an 1m. 21 jeweled, finely balanced and perfectly adjusted movement. It has specially selected jewels, dust band, patent regulator, enameled dial, jeweled compensation balance, double hunting case, genuine gold-laid and handsomely engraved. Each watch is thoroughly timed, tested and regulated, before leaving the factory and both the case and movement are guaranteed for 25 years.

Clip out this advertisement and mail it to us to-day with your name, postoffice address and nearest express office. Tell us whether you want a lady's or gent's watch and we will send the watch to your express office at once. If it satisfies you, after a careful examination, pay the express agent $5.45 and express charges and the watch is yours, but if it doesn't please you return it to us at our expense.

A 25-Year Guarantee will be placed in the front case of the watch we send you and to the first 10,000 customers we will send a beautiful gold-laid watch chain, Free. We refer to the First National Bank of Chicago, Capital $10,000,000.

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CARD CASES

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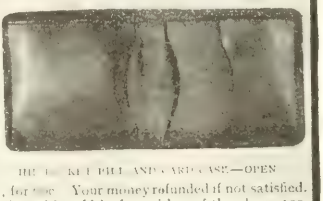

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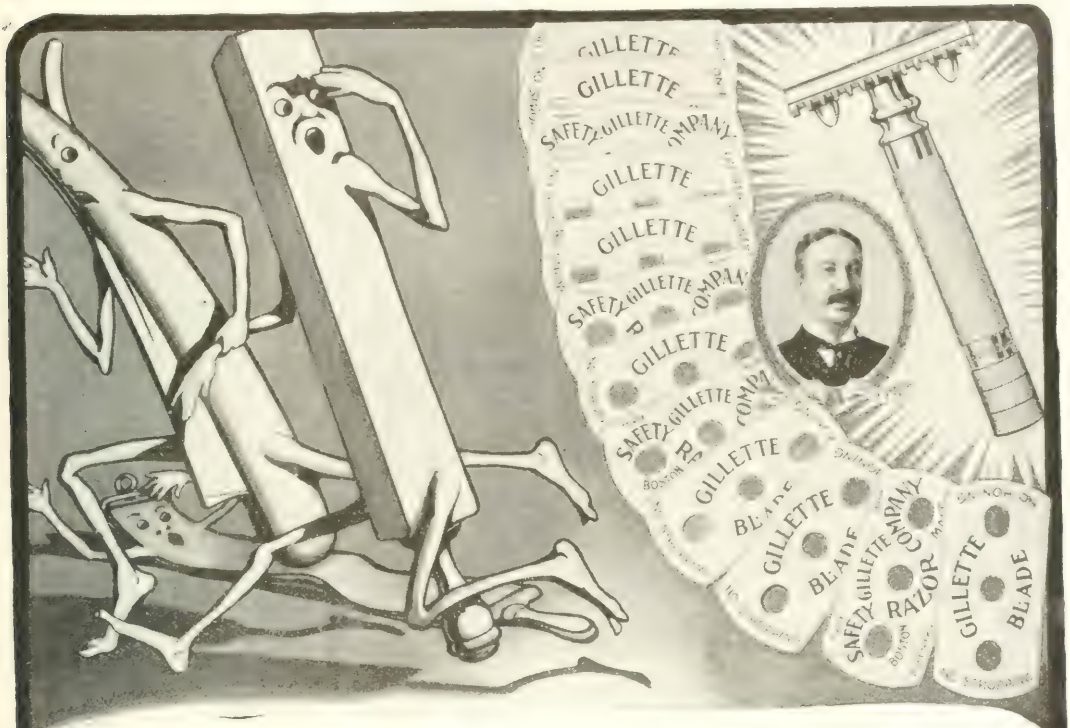

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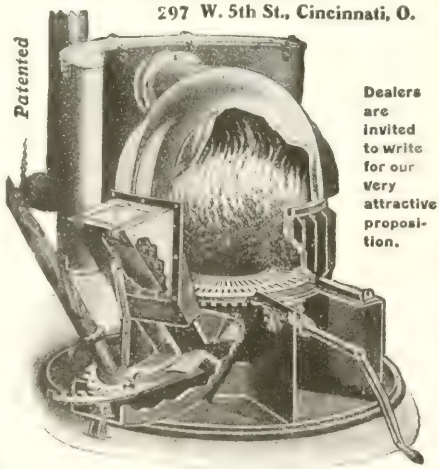

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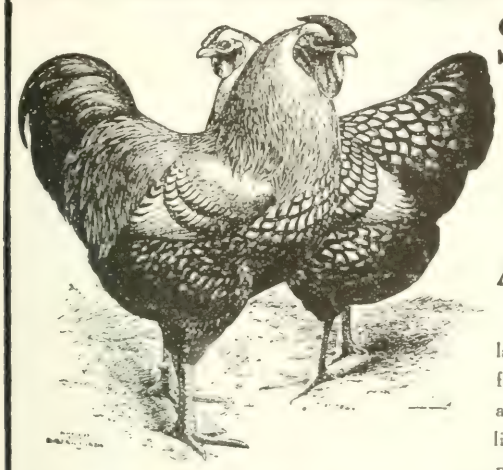

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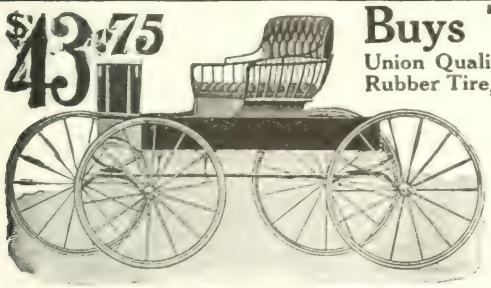

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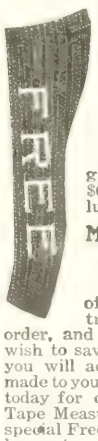

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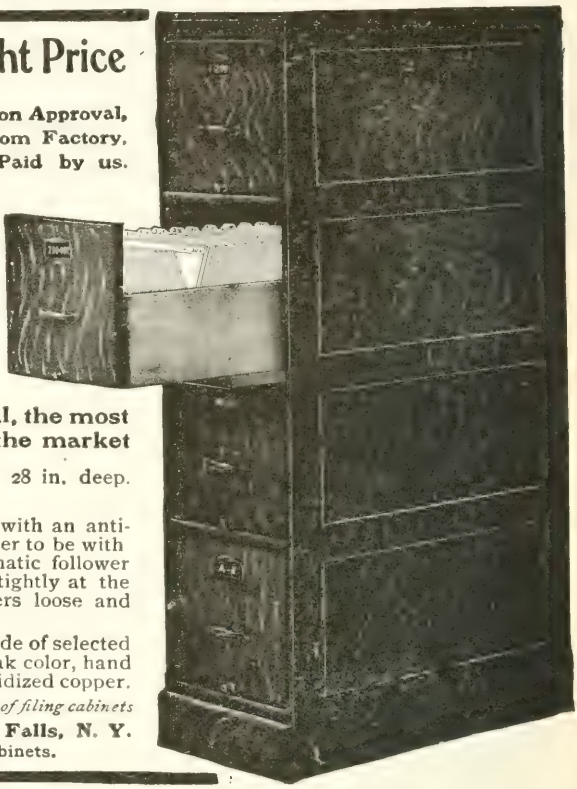

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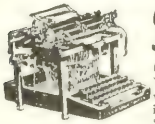

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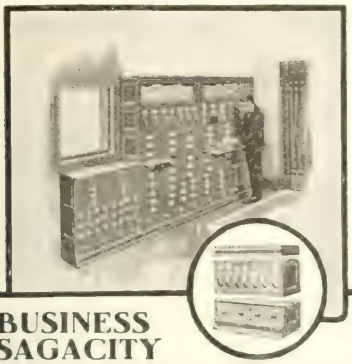

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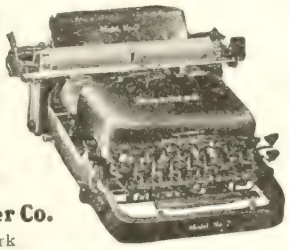

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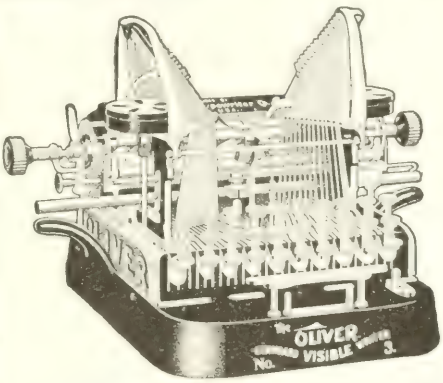

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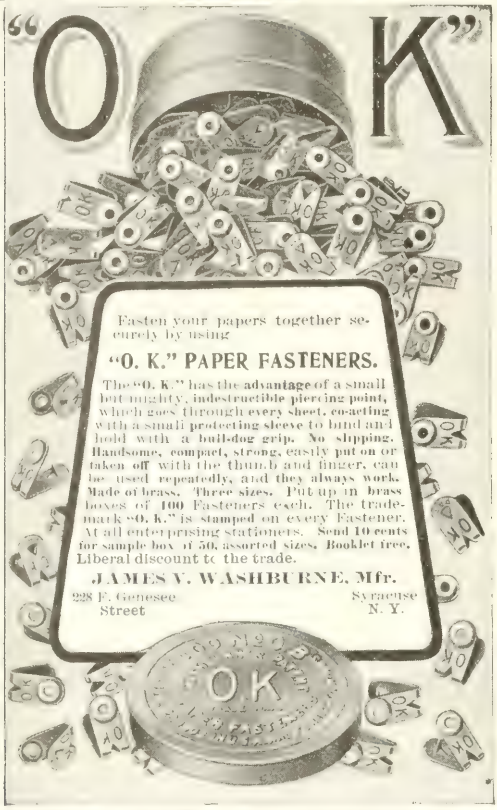

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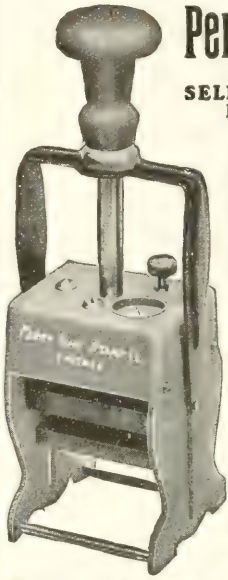

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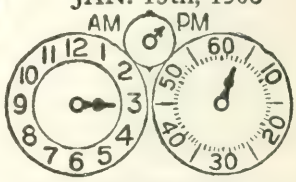

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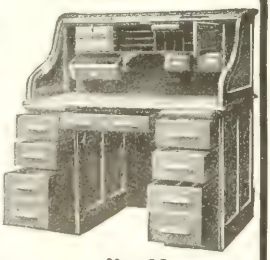

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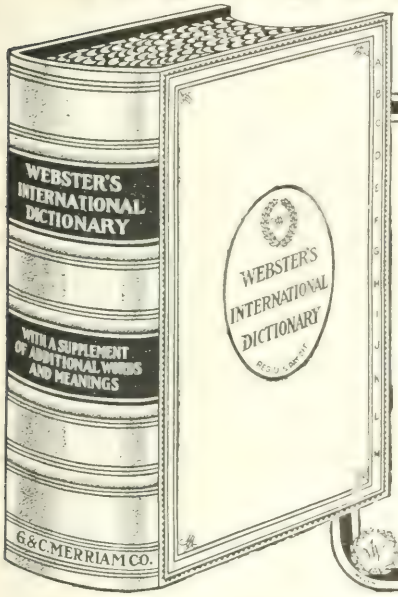
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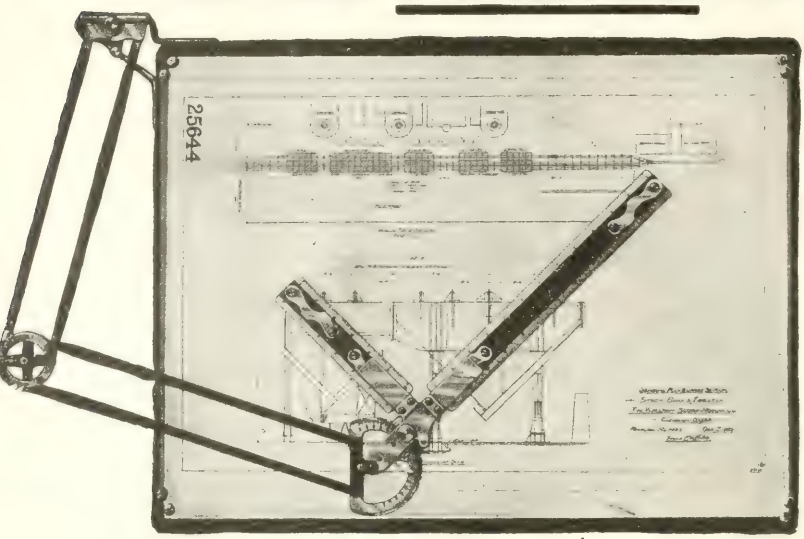

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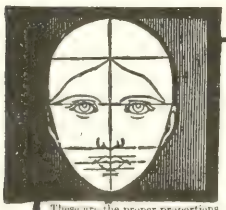
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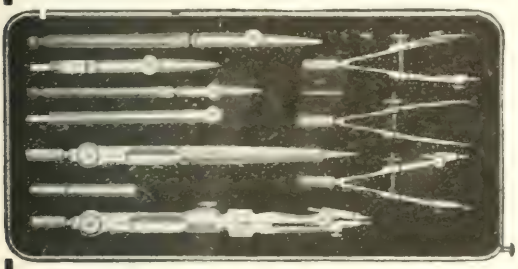

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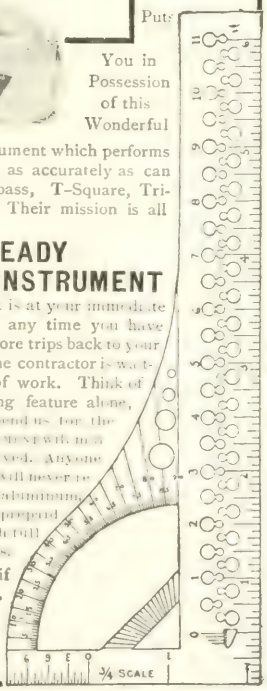

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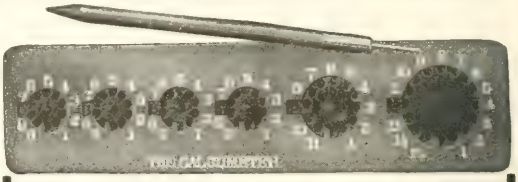

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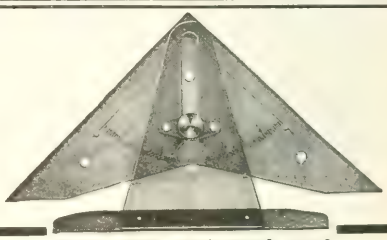

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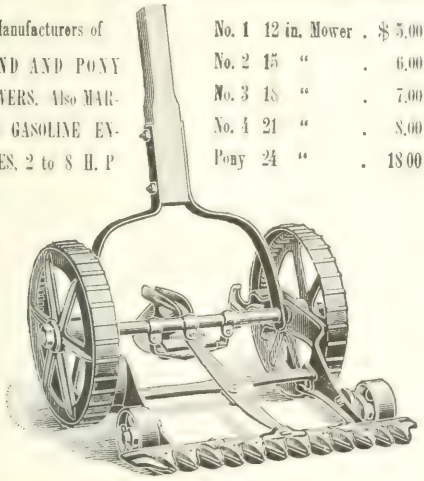

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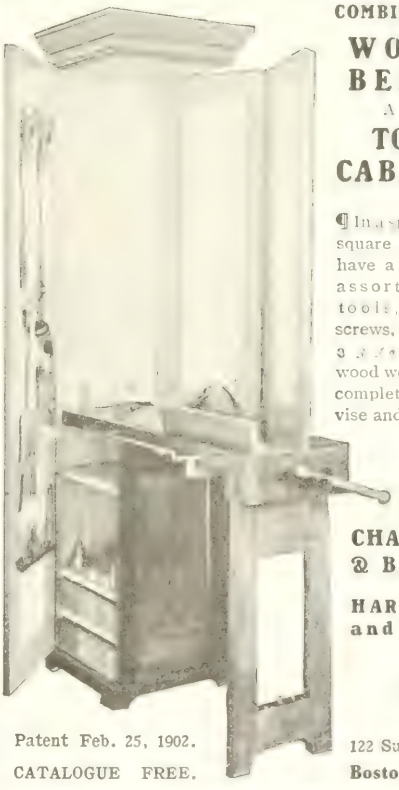

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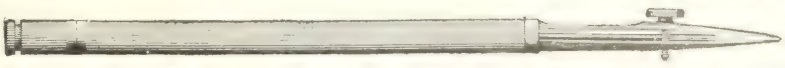

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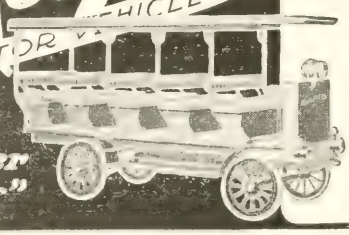

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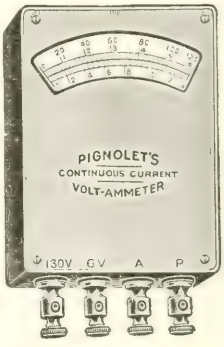

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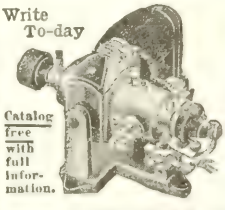

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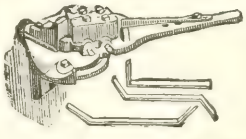

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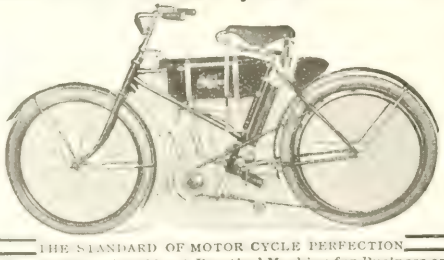

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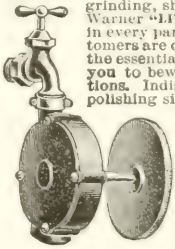

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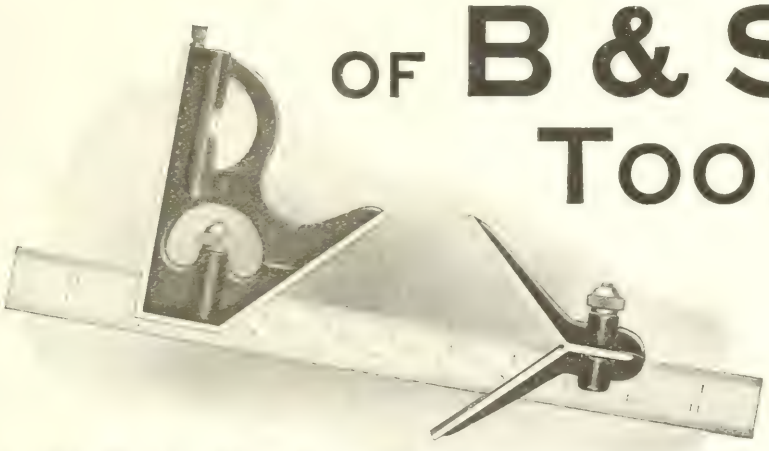

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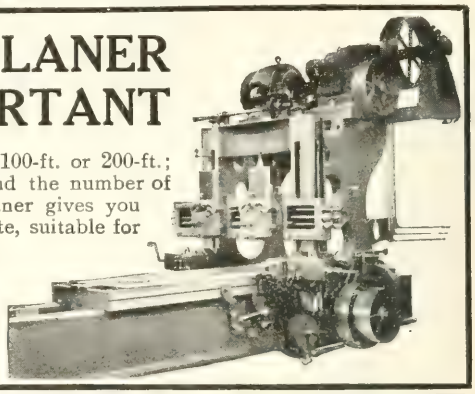

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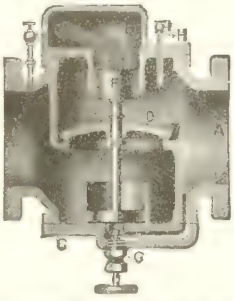

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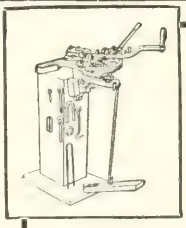

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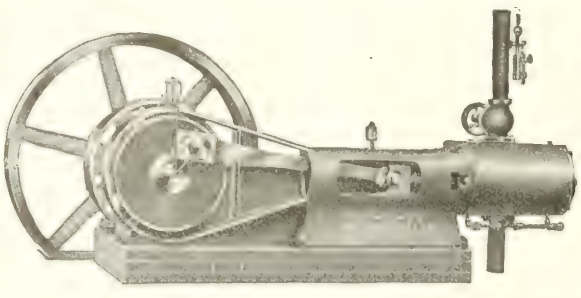

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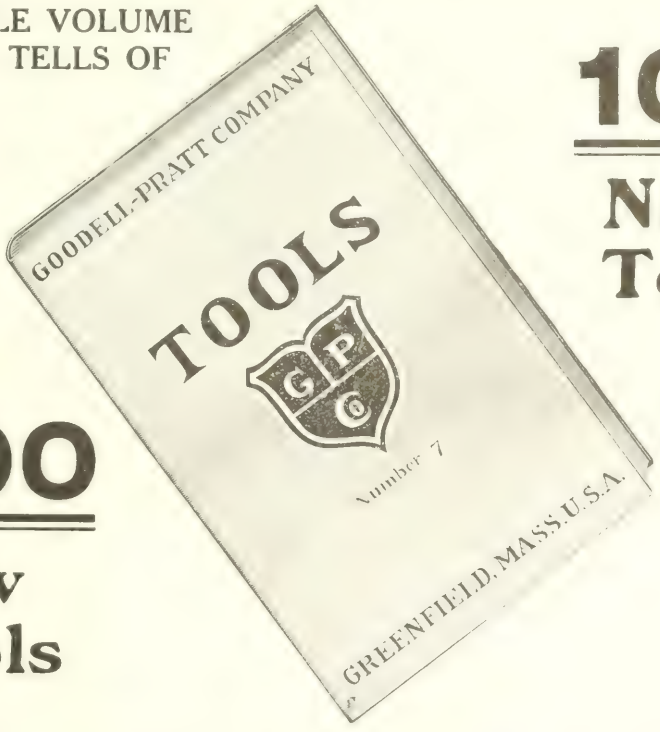

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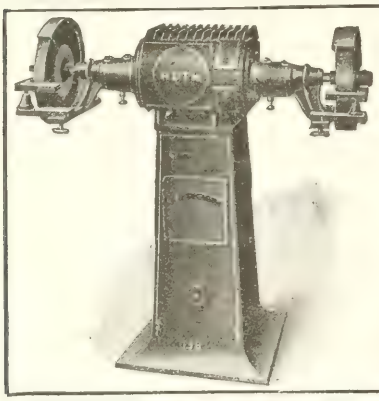

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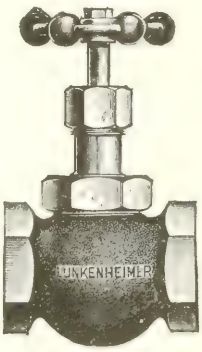

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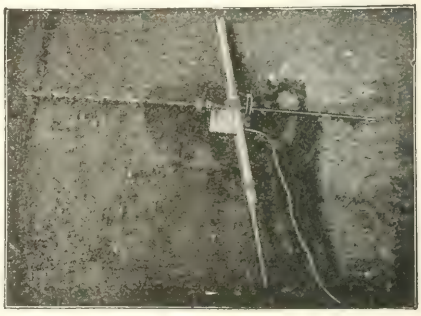

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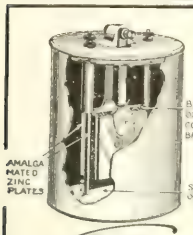

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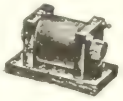

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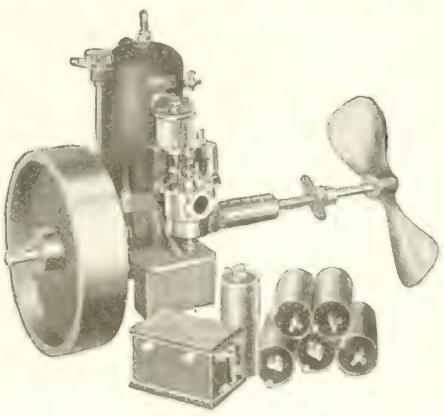

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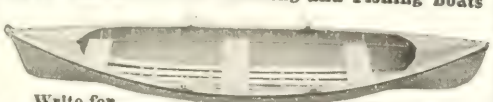

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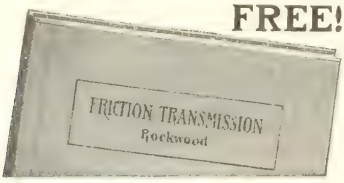

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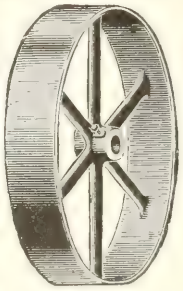

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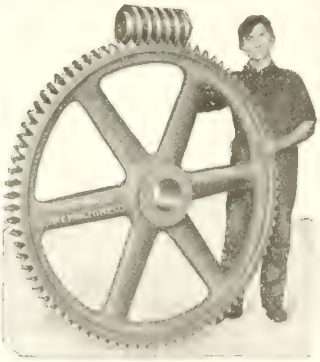

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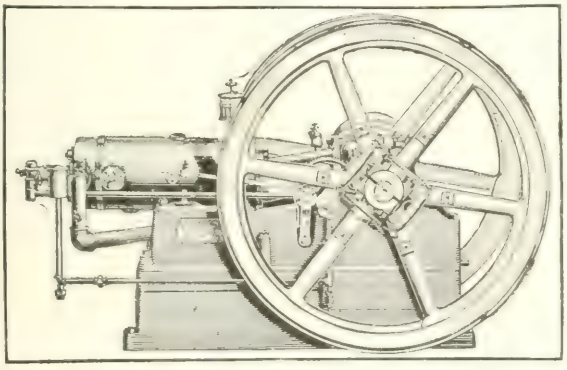

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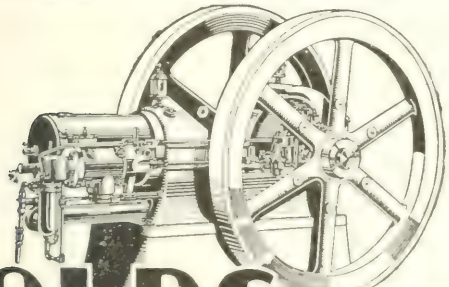

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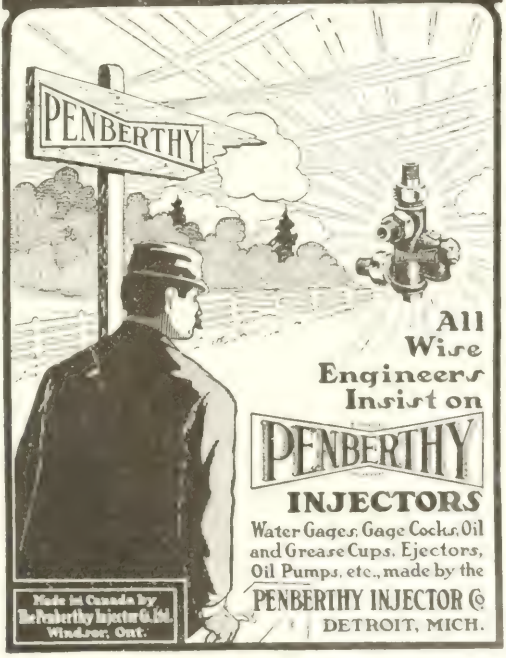

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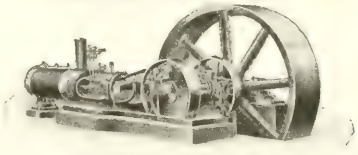
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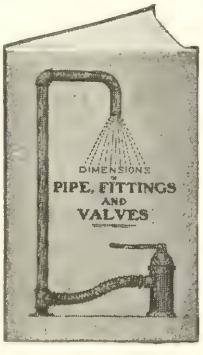

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LIQUID Stone is the striking title of an article by D. M. Harper, Editor of Concrete, in Technical World Magazine for May. It describes the marvellous new uses to which cement is being put—from fence posts to towering sky-scrapers.

T·W·M

Tell your newsdealer to save you a copy. Last issue was sold out six days after publication.

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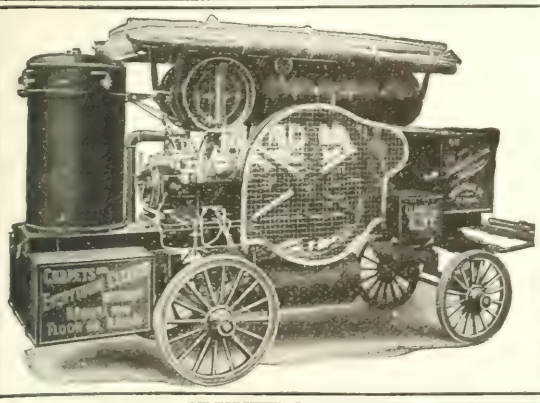

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IT CLEANS houses by compressed air without dust or disturbance, cleans carpets, curtains or furniture without removing from the room. Much cheaper as well as more convenient than the old way. ¶ If you live in a town of over 5,000, form a company and secure the exclusive right to use this system. Every housewife will be glad to patronize you. Every church, lodge, theater or club is an immediate and permanent customer. You will make money from the start, and have practically a monopoly of the house cleaning business. ¶ This is not a cheap proposition, but affords a great opportunity for the man with a few thousands to invest in a business.

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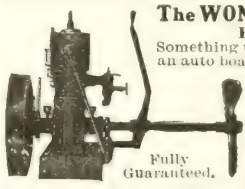

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Something to convert the row or sail boat into an auto boat. It is so simple any one can operate it. No valves, gears, cams, etc. The simplest, strongest and lowest price outfit on the market. Rated at 1½ h. p., furnishes nearly two. Solid or reversing propeller. Jump spark. Prices will surprise you. Supply is going to be limited. Write today. Will easily drive any size of boat up to 18 foot.

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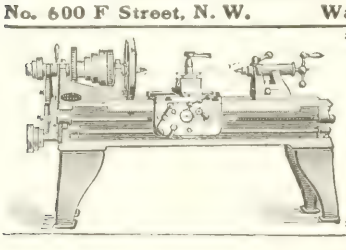

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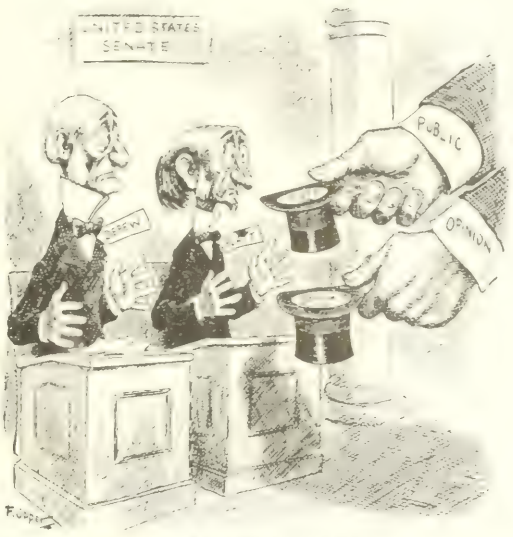

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The above is a humorous interpretation of a tremendously serious fact.

With several members summarily asked to resign, five more under indictment, and one dead in state's prison, an abrupt crisis has been reached in the Senate.

The situation has been admirably summed up by David Graham Phillips, as follows:

"The Treason of the Senate! Treason is a strong word, but not too strong, rather too weak, to characterize the situation in which the Senate is the eager, resourceful, indefatigable agent of interests as hostile to the American people as any invading army could be—interests that manipulate the prosperity produced by all, so that it heaps up riches for the few—interests whose growth and power can only mean the degradation of the people, of the educated into sycophants, of the masses toward serfdom.

"The Senators, as Senators, are not elected by the people—they are elected by the 'interests'; except in extreme and rare and negligible instances, the people can neither elect nor dismiss them."

It is the duty of every intelligent American to get a sane, sound understanding of these appalling facts. To learn the truth, read Mr. Phillips'

"The Treason of the Senate"

—the most scathing, truthful exposure of political corruption in years. Now appearing in the April

10 Cents a Copy

COSMOPOLITAN

One Dollar a Year

At all News-stands or Direct from the COSMOPOLITAN MAGAZINE, 1789 Broadway, N Y City

How to Advertise in a Small Way Successfully

FIRST, be sure that you have a good proposition—something to sell at a fair price that other people want to buy.

Second, put your proposition attractively, temptingly. Tell, in as few words as possible, just what you have to sell and just why the reader ought to want it.

Third, choose a medium that will reach the greatest number of people—of the sort whom your proposition is most likely to interest — for the least money.

But the ability to decide upon the worth of a proposition, the most effective way to present it, and the most economical means of placing it before the public comes only as the result of long experience.

The beginner, therefore, with the three fundamental rules above before him, has only one course to pursue. He must look for success where others have found it.

This does not mean that he must imitate blindly or appropriate others' ideas. But he must analyze each advertising success as it is pointed out to him and reapply for himself the principles and the methods involved. Every successful advertiser does this; it is the only assurance of advertising success.

If you have something to sell, analyze carefully the following advertisements and the partial stories of their successes. For these advertisers are pioneers in the classified magazine field, having used the first issue of a general magazine to carry a Department of Classified Advertising — the January number of EVERYBODY'S:

The Advertisements	The Results
REAL ESTATE	
MISSOURI FARM LANDS ON MONTHLY PAYMENTS. 80 acres, near railway, for $250, payable $5 cash and $5 monthly; no interest; good title; healthy; 40 acres, $125; plots and particulars furnished. J. W. Kerr, 902 Chestnut St., St. Louis, Mo.	"A large number replies; more by every mail. Have sold two pieces of property through this advertisement." J. W. Kerr.
BUSINESS OPPORTUNITIES	
SCIENTIFIC HOUSE CLEANING—For Sale—Compressed Air house cleaning wagons and exclusive territory in which to operate them. Wagons earn their cost every year An independent business for anyone who can command $3,000.00 capital. State references. Men of business reputation only considered. Address American Compressed Air Cleaning Co., 452-454 East Water St., Milwaukee, Wis.	January 15th. "More than surprised at results. We had between 40 and 50 replies, but the best part of it was they were scattered all over the United States as well as from Canada." Am. Compressed Air Cleaning Co.
HIGH-GRADE HELP WANTED—AGENTS, ETC.	
WANTED UP-TO DATE CAPABLE agents to handle new high grade up-to-date article easily carried in pocket, lightning seller in all offices, stores, shops, or homes. Thomas Mfg. Co., Department E Dayton, Ohio.	January 20th. "200 replies; many agents secured; replies still coming and end doth not appear." Thomas Mfg. Co.
MISCELLANEOUS	
DO YOUR OWN PHOTOGRAPHY. Any one can do it at home, no toning, no dark room, no mystery, print fine platinum toned pictures of your own portrait on any textile fabric, paper, post cards, wood, etc. Beautiful work for home decorations, outfit sent prepaid on receipt of $1.00, larger size printing 3 colors, $1.50. Agents wanted. Home Photographing Company, Box 134, Cleveland, Ohio.	January 17th. "The results simply amazing — 163 replies; 92 sales, and replies still coming in averaging ten a day." Home Photographing Co.

These results, large as they seem, are in keeping with EVERYBODY'S record as the general magazine of largest circulation and lowest advertising rate—the biggest producer of results for advertisers of everything of high grade.

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Send this coupon, with check, before February 28th to be in time for the April Number

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Please insert the classified advertisement below in the next issue of EVERYBODY'S MAGAZINE. ENCLOSED is _____ for $_____ in full payment

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Allow about nine words to the line; most of the fourth line for name and address. 4 lines, $9.00—$2 25 per line additional.

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Does not set quickly like the old style glue; has four times the strength (Official test, one in. sq. hard pine butted, registered 1620 lbs. before parting). Used by the best mechanics and manufacturers everywhere.

Nearly 3 Million Bottles sold yearly, besides the can and bulk Glue for Mechanics and Manufacturers' use.

Either the one ounce Bottle or **Patent Collapsible Tube** (seals with a Pin), retailing for 10 cts., mailed for 12 cts., if your dealer hasn't our line. Specify which.

LEPAGE'S PHOTO PASTE
2 oz. size retails 5 cts.; by mail, 10 cts.

LEPAGE'S MUCILAGE
2 oz. size retails 5 cts.; by mail, 10 cts.

are like the Glue, unequalled, the best of their kind in the world, and are put up in convenient and attractive pkgs.

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The newest and most comprehensive treatise on the Greek and Roman orders published. ¶ Invaluable to architects, draftsmen, art students and every lover of art. 400 pages of text, bound in half morocco and a

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Ready for delivery April 1st.

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Price, $8.00 delivered (regular price after April 1st, $12.00). Terms: $1.00 down and $1.00 per month for seven months. Cash with order, $7.00. Money refunded if not satisfactory.

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It is all figured out in our Booklet T, which also tells how to bank by mail.

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The People's Savings Bank was founded forty years ago — has the largest capital and surplus of any savings bank in the world and accepts savings in any amount from $1 up.

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Pittsburgh, Pa.

4% THE BANK THAT PAYS 4%

$25 TO North Pacific Coast Points

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St. Paul and Minneapolis to the Pacific Northwest.

For free descriptive booklets write C. W. Mott, General Emigration Agent. For information about rates and trains write A. M. Cleland, General Passenger Agent, St. Paul, Minn.

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Only Railroad South

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Equipped with Automatic Electric Block Signal System, from Cincinnati to all important cities South, Southeast and Southwest.

W. C. Rinearson, G. P. A.
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Cincinnati, O.

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T·W·M

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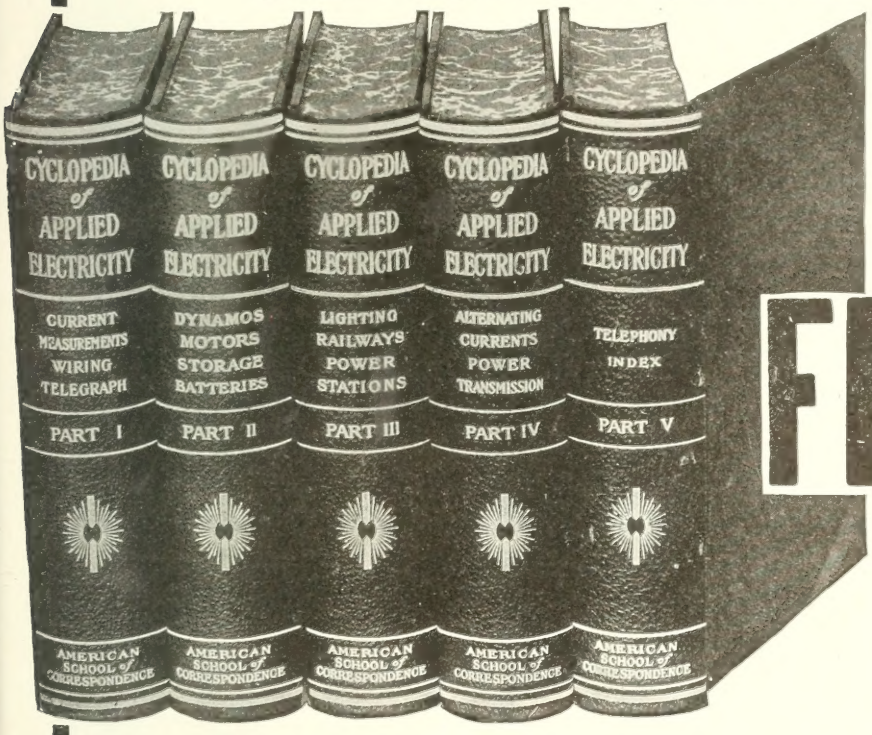
Five Volumes—2,500 Pages—Fully Indexed—size of page 8x10 inches. Bound in ¾ Red Morocco. Over 2,000 full page plates, diagrams, tables, formulæ, etc.



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PROF. WILLIAM ESTY, head of the Department of Electrical Engineering, Lehigh University.
H. C. CUSHING, Jr., Wiring Expert and Consulting Engineer.
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WILLIAM BOYRER, Division Engineer, N. Y. and N. J. Telephone Company.
CHAS. THOM, Chief of Quadruplex Dept. Western Union Telegraph Co.
PROF. LOUIS DERR, Massachusetts Institute of Technology.
PERCY H. THOMAS, Chief Electrician, Cooper-Hewett Co., N. Y. City.
A. FREDERICK COLLINS, Author of "Wireless Telegraphy."

For Contents see titles of books

American School of Correspondence
Chicago, Illinois

COUPON—CUT OUT AND MAIL TO

American School of Correspondence, Chicago, Illinois.
GENTLEMEN:—Please send me, express prepaid, one set "Cyclopedia of Applied Electricity" on the following terms: If satisfactory, I agree to remit $1.00 and $2.00 per month thereafter for nine months. Otherwise I will notify you within five days you will send for the books. Cash with order $18.00. Money refunded if not satisfactory.

Name.....
St. and No.....
City.....
State.....
Employer

T.W. Apr. '06

Figure It Out

Did you ever stop to consider the *money value,* of the energy you waste?

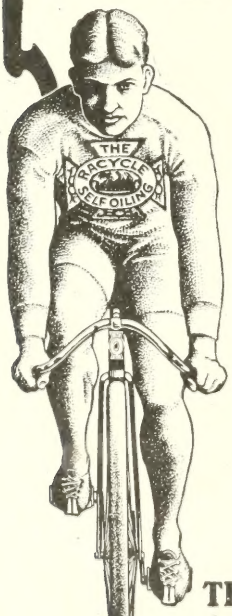
Here's a simple, but mighty convincing, illustration:

Two walking steps are equal to *one* revolution of a bicycle pedal.

The ordinary man covers a little over five feet of ground in making two steps. The average bicycle rider will cover seventeen feet with one revolution of his pedal.

But—on a

RACYCLE



with its standard gear, a rider will travel *twenty-one feet* per pedal revolution, and with *much greater ease* than either the pedestrian or the other cyclist.

Ride a **Racycle** and store your power. Write us and we will be glad to explain *why* the **Racycle** pushes farther and faster than any bicycle.

We have no cheap RACYCLES, but try and secure agency for your town and get yours cheap

THE MIAMI CYCLE & MFG. CO., Middletown, O., U. S. A.

Beautiful 1906 Catalog sent on receipt of 2 cents postage—FREE—*if you mention this publication*

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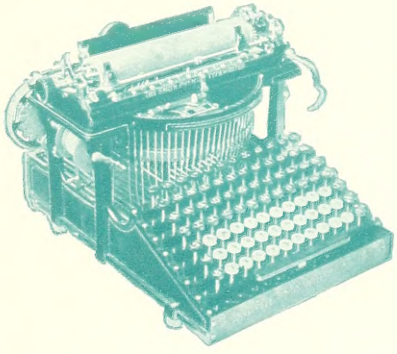
are erected by riveting steel beam to steel beam. The rivets, compared to the girders they hold in place, are insignificant, but without them the modern skyscraper would be impossible. Business letters are the rivets in business building. On their effectiveness the stability of your own business depends.



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makes
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TRADE MARK
SUSPENDERS

I make the GORDON Suspenders in four lengths 33, 35, 37, 40 inches

I want you to examine the **slide webb** back in my GORDON Suspenders; it moves on your back **without friction.** My GORDON Suspenders will not twist out of shape, do not bind your shoulders. Neither do GORDON Suspenders **stretch** out of shape. My GORDON Suspenders are the one-dollar kind, but you buy them for

50 CENTS

When writing me for booklet or suspenders, please mention Department Key 20. That means you read this magazine.

I will sell to every man some day my GORDON Suspenders. It may take advertising to reach you, but I will spend the money. My GORDON Suspenders are the simplest and easiest kind made. Your dealer should supply you. If he hasn't them he can get them. (Any man writing me on his business stationery can get the GORDON Suspenders on approval. Examine them, test them, then send me 50 cents in my coin card, which you will get, or return suspenders.) I make this offer so that you can be supplied if your dealer hasn't them.

Try your dealer first

Gordon Manufacturing Co. **50 Cts.** **NEW ROCHELLE NEW YORK**

¶ The picture depends on the film, far more than on lens or on camera .. ..

"KODAK" FILM

has 20 years of experience behind it—it's ***not*** in the experimental stage .. ..

Look for Eastman on the box
Look for Kodak on the spool

EASTMAN KODAK CO.

Ask your dealer or us to put your name on list for spring catalogue "when ready."

Rochester, N. Y.
The Kodak City

MENNEN'S
BORATED TALCUM
TOILET POWDER

Pure as the Lily

—healthful and refreshing; that is why MENNEN'S is always used and recommended by physicians and nurses. Its perfect purity and absolute uniformity have won for it universal esteem. In the nursery it is supreme, unequalled for **chafing, nettle-rash, chapped hands,** etc., it is soothing, sanitary and healing. MENNEN'S face on every box—see that you get the genuine. *For sale everywhere or by mail, 25c. Sample free.* MENNEN'S VIOLET (Borated) TALCUM has the scent of fresh cut violets.

GERHARD MENNEN CO. — NEWARK, N. J.

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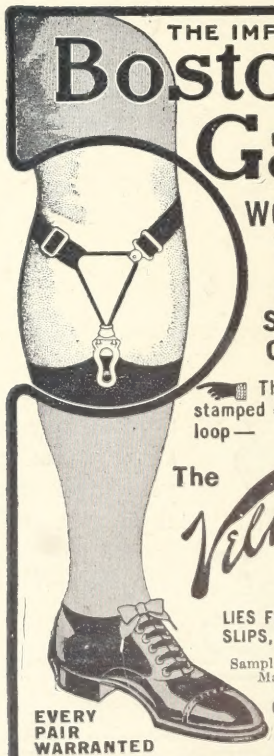

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